TIMBER FRAMING

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Sojourn with Compagnons

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On the front cover, upper framing of conical roof capping a 60-ft.-tall, 40-ft.-dia. stone tower, 16th or 17th century, part of town offices in Bourganeuf (Creuse) in the Limousin, central France; lower framing shown on back cover. Photos Will Gusakov.

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NOTES & COMMENT

AN appeal arrived recently in my email suggesting, not for the first time, that hybrid timber frames are the future. I might agree, but the "lick and stick" hybridization suggested—focused on great rooms, porches and corbels—doesn't fit for me. Who among us hasn't been paid somewhere between eight and eighty thousand dollars to provide components to a house, and left the installation aware and possibly disgusted that our craft's capability for real structural work had gone unnoticed? Those four trusses we provided for the greatroom were tucked underneath gangnail scissor trusses. The 48 corbels we built were slapped on the OSB walls, then sided and caulked in. Front porch cost $100 a sq. ft. Really? Our work was expensive, unnecessary and for the wealthy. Let's face it, no one *needs* three trusses in the great room, corbels on the gables, or a disproportionately small kingpost truss at the entrance. When our work was done, what real value had been added to the house? You may tout the intangibles, the warm fuzzies of craft, but good luck with that argument when the money gets tight. I can almost guarantee that your warm fuzzy scope will be cut long before the hand-cut tile, polished brass fixtures or (cold, hard) granite countertops are even considered.

Perceived value is a funny beast, so let's resist the futile conversation that insists that the public should cut out the polished brass and leave in your timber frame. What if, instead of insisting that our craft had value, we could actually prove that it does? That its inclusion is essential, doesn't drive up the price by 15 percent plus and actually requires no emotional currency from the owners? Is that a future we can embrace as good, and can we get there? Do we want to?

I think we have to do this. We are currently all too similar to vaulted drywall great rooms and jetted master tubs. (Those folks think what they do is pretty valuable, too.) Too much of our work has been for the exclusive clientele and hasn't been forced to prove its own worth. Our saving grace may be that it actually can. They didn't timber frame barns in Ohio in the early 1800s because it was cool and felt nice. They did it because it made sense. It still can. In fact, the historical precedent for our trade has been predominantly functional. We now find some timber-framed barns stunningly beautiful, but function was the real reason they ever existed. Who can doubt that the grace of canted queenpost, principal purlin roof systems doesn't make perfect structural sense? For too long now, we revivers have made ourselves into artists. We're builders and, if we push ourselves to make real sense, the next efficient truss is waiting to be developed.

This economic crisis, for all of its inconvenience and hardship, needed to come. You may care to extrapolate or distill this conversation about timber frame function to include social, moral, financial, political and spiritual issues. I certainly do. As a society, we've lived way too long with concepts, beliefs and things that serve no real purpose except to amuse us. No way can this planet sustain our appetite. We'd better get moving. In the best possible future, there are no literal or spiritual corbels, no fake trusses in our houses or spanning the great rooms of our minds—and simply no excuses for wasting anything or any effort solely for status or pleasure. Please stop asking your potential clients and the public at large to support you because living in a timber-framed house feels good. Instead, force yourself to prove that you have value to provide your fellow humans and can provide it to your financial peers, not your benefactors. They're the clients that we're missing. —Adrian Jones

TTRAG 2010

THE Guild's Traditional Timber Framers Research and Advisory Group held its 19th annual public symposium May 21–23 at the Holiday Inn, Schenectady, New York, in the thick of Dutch colonial America, a region arguably as rich in 18th-century architectural history as New England or the Old South. A tour of Schenectady's Stockade District preceded an evening of plenary presentations, including Jan Lewandoski on Champlain Island framing (this page), Lisa Sasser on why preservation matters (page 6) and John Stevens on Dutch buildings in North America (page 8). A day out followed at Mabee Farm in Rotterdam Junction, home of the Schenectady County Historical Society, for demonstrations, presentations and tours of the Dutch-American buildings there and nearby, including the iconic Wemple homestead. The symposium concluded with a morning of presentations, two of them illustrated autobiographies (overleaf). In addition, Walt Wheeler spoke on framing strategies of late New World Dutch carpenters, Alex Greenwood and Elric Endersby described a wealth of Dutch-framed outbuildings and, in the relocated Nilsen barn at Mabee Farm, Frank Taormina of the Schenectady County Historical Society and Ned Pratt of the Dutch Barn Preservation Society discussed the framing and history of Dutch-American barns.

Framing on Vermont's Lake Champlain Islands

Jan Lewandoski

LAKE Champlain is 130 miles long, with the head of the lake at Whitehall, New York, and the outlet in southern Québec, where the Richelieu River drains it to the St. Lawrence. The watershed includes much of western Vermont and large parts of northeastern New York as well as Québec south of Montréal. Disputed for centuries by Iroquois, Huron and Algonquin, this beautiful lake and its islands were sparsely inhabited. The French established a series of tenuous, impermanent settlements between 1609 and 1759, until they were pushed out by English and Colonial American forces. Military activity during the Revolutionary War rendered settlement difficult, and not until the 1780s and later did the earliest buildings we see today come into existence.

Lake Champlain has numerous small islands. At its northern end, a chain of larger ones, Grand Isle, North Hero and Isle LaMotte, along with the Alburg peninsula (attached by land only to Canada), form Grand Isle County in Vermont. While the islands do not represent a distinct cultural tradition from the rest of Vermont, and thus possibly a distinct framing tradition, they do have distinct geographical and agricultural characteristics and certain particularities in the framing.

The islands have extensive limestone quarries and much more combining of stone and timber in buildings than elsewhere in Vermont. Included in this stock of buildings are two-story limestone houses, a church, a library and a 90-ft.-long limestone barn with timber roof and floor systems, shown under restoration at right above (1).

While surrounded by water, the islands are low and thus lack water power, so we see a tendency to hewn, riven and even pitsawn timber at later dates than on the mainland, and possibly a greater frequency of log building. Consequently, surviving construction may appear more archaic than would be expected in the first quarter of the 19th century. At the Grand Isle County Courthouse (2), these archaic material conversions are joined into an archaic medieval-style truss (3) that would have seemed distinctly out of place when built in the 1820s elsewhere in New England or New

1

Photos Jan Lewandoski

York, particularly in a prominent and well-funded public building. A ca.-1805 log house on Hog Island in Swanton is built of hemlock timbers, hewn three sides and pitsawn on the fourth. Early threshing barns are often framed with hardwood posts turned flatside in the walls, dropped tie beams, round pole common rafters and riven bracing (4).

The moderating effect of the lake led to an apple industry, established at an early date. Along with it came barns called "fruit houses," similar to typical 30x40-ft. early barns elsewhere but with a drive only 8 or 9 ft. wide, apparently to accommodate fruit wagons. Both examples I have seen, one from about 1805 and another from about 1850, were studded vertically, but this may have been just a framing choice with no relation to function. One fruit house is still being used to press and store apples and cider.

2

3

4

Photos Don Carpentier

Don Carpentier, founder, director and *genius loci* of Eastfield Village, Nassau, N. Y., and collector from an early age of anything from bottles to buildings, who surveyed his career in his talk "The Evolution of a Craftsman" at TTRAG 2010, shown with finely wrought sled in 1969 in his "Chicken Coop." At top right, work from Early Carpentier Colonial period (1968). Above right, Briggs Tavern (originally 1793) in mature Late Carpentier Colonial style.

A polymath and distinguished potter, Carpentier annually administers a range of lectures and workshops in traditional crafts, housing students in village buildings, which date from 1787–1840. Above, 1840 blacksmith shop, the first building moved to the village, suffering badly (left), then repaired and enlarged in kind (middle and right). At far left, selection of Carpentier's glazed chinaware. At left, sheet metal lantern in 19th-century pattern.

Ellen van Olst

Jack Sobon

Randy Holdredge

Jack Sobon's talk at TTRAG 2010, titled "Working by Hand, a Course for the Future," likewise surveyed a rich career as a craftsman. Author, architect and timber framer, Jack appears above with layout square, Windsor, Mass., 1992, pictured with (from left) Dave Bowman, Dan Berube and Tim Berube. At top right, early colleague Paul Martin, Richmond, Mass., 1983, squaring a mortise end. At right, longtime collaborator Dave Carlon, Hancock Shaker Village, Mass., 2002, on the Millers Falls boring machine. Below, characteristic framing work. Left and middle, hewn oak crucks and mixed hardwood, Cummington, Mass. Right, elm tree parts, mixed species for house in Lenoxdale, Mass.

Jack Sobon

Lisa Sasser

Conservation as restoration: preparing to remove steel reinforcements inappropriately added to late-19th-century roof framing, Breeding Barn, Shelburne Farms, Shelburne, Vermont, 2010.

Why Preservation Matters

SINCE the 1960s, the US historic preservation movement has been a genuine grassroots success story, mobilizing activists against wholesale destruction of architectural heritage associated with urban renewal and highway infrastructure creation. In 1980, economist John Kenneth Galbraith observed, "The preservation movement has one great curiosity. There is never any retrospective controversy or regret. Preservationists are the only people in the world who are invariably confirmed in their wisdom after the fact." As we enter the second decade of the 21st century, some question whether the historic preservation movement is still relevant in the face of new environmental, demographic and economic challenges.

In 1994, in his seminal work *How Buildings Learn*, Stewart Brand observed, "It used to be that old buildings were universally understood to be less valuable than new. Now it is almost universally understood that old buildings are more valuable than new." Today, that valuation has been eroded by the idea that old buildings are costly, inefficient "energy hogs" that can't compete with new, "green" buildings. The preservation movement also suffers from the perception that maintaining historic buildings and sites is a dispensable luxury in a poor economy. In response to record deficits, more than 400 state parks and historic sites in 30 states face closure, leading the National Trust for Historic Preservation to place our state parks system on its 2010 list of Eleven Most Endangered Historic Places. The National Park Service, steward of more than 27,000 historic structures and cultural landscapes in 392 national parks, monuments and historic sites across the country, has a deferred maintenance backlog of more than $8 billion and an annual shortfall of approximately $600 million for operations and maintenance. Other important preservation programs at risk include Save America's Treasures, a 10-year-old public-private partnership that has awarded almost $294 million in grants for preservation of more than 1100 structures covering every state, leveraging more than $377 million in nonfederal matching funds, and creating as many as 16,000 jobs (many of them highly skilled jobs in the preservation trades). Historic preservation reviews have been cited in highly critical news reports as delaying and obstructing economic stimulus efforts, in large part because of chronic underfunding and understaffing of state historic preservation offices.

Clearly, the historic preservation movement is going through an identity crisis. Preservationists point with justifiable pride to the economic benefits of rehabilitating historic buildings, such as the use of federal rehabilitation tax credits to drive the investment of $85 billion in preservation and rehabilitation projects across the country, as well as creating jobs and preserving places that people care about. The phrase, "the greenest building is one that is already built," coined by architect Carl Elefante, has both logic and statistics to back it up. Still, the preservation movement is plagued by the perception that it's all about "saving old buildings."

The mainstream preservation movement has been challenged to defend its relevance in the face of economic crisis and a cultural shift towards sustainable development envisioned largely as the application of new technology to retrofitting the built environment. Groups such as the National Trust for Historic Preservation are making a committed effort to reinvent and retool the preservation movement for the 21st century. Richard Moe, the immediate past president of the National Trust, put the problem thus: "Older buildings are part of the solution to larger challenges, such as how we support environmental sustainability, adapt to population changes and growth, and promote job creation and economic development. While preservation can be a force and a powerful tool for these and other pressing needs, all too often it is unacknowledged."

While the recent history of the Trust under Moe's leadership has been characterized by programs to build community-based preservation efforts and partnerships and invest in research on sustainability and economic benefits of preservation, it is perhaps no surprise the new president of the National Trust, Stephanie Meeks, spent 18 years on the staff of the Nature Conservancy, the nation's largest environmental nonprofit, in positions including chief operating officer and acting president. It's clear that the preservation movement has absorbed some of the lessons of the environmental movement and is ready to broaden the focus from preservation to conservation.

WHAT'S in a word? The term *historic preservation* is in general use only in the United States. Throughout the rest of the world, the practice of maintaining historic structures is almost universally known as *conservation* or, more specifically, conservation of the built environment. This distinction has had important consequences. First, *conservation* is the accepted term for stewardship of the natural environment. Using a different term for sustaining built heritage exacerbates a disconnect between the two. And second, the term *preservation* conjures the image of something pickled in a jar, frozen in time and placed on a shelf. Conservation, by contrast, conveys the process of maintaining the vitality of dynamic systems. The built environment is arguably as mutable and dynamic as the natural environment, and just as endangered in terms of its vitality, sustainability and quality.

The term *historic preservation* has been thoroughly codified into laws, policies, standards and guidelines in the US for more than 40 years. It's instructive to know how it came about. In 1964, the US delegation to the second International Congress of Architects and Technicians of Historic Monuments rejected the terms of the Venice Charter, a short document drafted in French that laid out guiding principles for an international accord on the study and safeguarding of architectural heritage.

In the US in 1964, restoration of historic buildings and reconstruction of vanished ones were primarily the work of professional preservationists. European practitioners defined treatment of historic structures broadly to include respecting work of different periods, which could cast doubt on the principles and approaches of American work of that time. It's conceivable that the term conservation caused some discomfort in the US delegation because of its association with the then-upstart environmental movement at home in the US.

Vince Michael, Chair Emeritus of the National Council for Preservation Education, is one of many voices making the case for practicing heritage conservation instead of preservation: "Heritage conservation is not about fixing a site to a certain date or epoch. It is, instead, about the process of managing change over time—planning—and doing so in a manner consistent with the history, culture and resources of a specific place." Tools such as the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (1995) supply the broad philosophical framework, but the process of managing change in concert with the values of place requires knowledge and regard for the characteristics, materials and forms of historic construction.

The evolving preservation movement of the 21st century has firmly grasped the idea that its purpose has as much to do with communities, livelihood and sense of place as with bricks and mortar. Winston Churchill famously observed that while "we shape our buildings, thereafter our buildings shape us." Just as buildings have embodied energy, the best of them contain the embodied knowledge of the people, traditions and skills that created and sustained them over time.

There are perhaps few other groups as attuned to this idea as the Timber Framers Guild, and few as firmly committed to creating—as well as conserving—structures that future generations will care about. As an organization founded on a traditional system of building knowledge, the Guild has moved timber framing from a historical footnote to a vibrant community of practitioners with a solid body of newly made and restored buildings, as well as research, publications, education and community engagement. Pursuing its own path of development in both new and traditional building practice, the Guild has evolved in ways that place it at the forefront of emerging principles in the preservation movement.

The contributions of the Guild have been recognized by the World Monument Fund, and the National Center for Preservation Training and Technology (a research division of the National Park Service established in 1994) supported the Guild's publication of *Historic American Timber Joinery: A Graphic Guide* by Jack Sobon and *Historic American Roof Trusses* by Jan Lewandoski. Guild members have long been active as speakers and presenters at events and conferences sponsored by the National Trust, the Association for Preservation Technology, Restore Media and other preservation organizations. At the most practical level, the collective work of the members of TTRAG, the Guild's historical specialists, has made a direct contribution.

In the nearly 50 years since the Venice Charter was written, the traditional Western definition of "authenticity" in relation to cultural resources has evolved, partially through the influence of international heritage documents such as the Nara document of 1994 (Japan), the Burra Charter of 1999 (Australia) and the Xi'an Declaration of 2005 (China), which emphasize the importance of "intangible" heritage, setting and traditional practices. These documents temper the view of historic buildings as static artifacts, to be preserved through technical interventions, with respect for the value of workmanship and the importance of transmitting traditional trades skills in continuing use.

It's been said that the preservation movement reinvents itself every 25 years. The current wave of reinvention is probably past due, and certainly made more challenging by the host of external factors impacting both the continued existence and appreciation of cultural heritage. Richard Moe has said that one of the main challenges of the "new" preservation is to communicate that "Historic preservation has evolved into something much more than just saving buildings. Today it is about people and the places that they care about." This concept is nothing new to the Guild; it's practically a part of TFG collective DNA. Through continued development of educational programs and partnerships, research and collaboration, the Guild and its members have an opportunity to play a significant role as advocates for cultural heritage as well as livable and sustainable communities. —Lisa Sasser

Lisa Sasser is a historical architect and preservation specialist who has worked in preservation since 1972, including 30 years with the National Park Service. She is a founding member and past president of the Preservation Trades Network and currently a member of the Guild's board and executive committee. A complete list of citations for this essay, edited from the transcript of her talk at TTRAG 2010, can be obtained from her at lisa@quid-tum.com.

Photographer unknown, Historic American Buildings Survey (HABS)

1 Abraham Yates house, ca. 1725, Schenectady, N.Y.

Dutch Buildings in North America

IN 1609, while in the employ of the Dutch East India Company and attempting to find a "Northwest passage" through North America to the Pacific Ocean (and the riches of the Far East), English mariner Henry Hudson sailing in the *Halve Maen* explored the river that now bears his name. Hudson's exploration led the Dutch Republic to claim a sizable piece of North American real estate, and soon Dutch adventurers began to exploit the territory's resources, in particular the beaver skins supplied to them by the Indians, which were in great demand by European hat makers.

In 1624, the territory, which they named Nieuw Nederland, officially became a Province of the Dutch Republic, administered by the Dutch West India Company, established in 1621. The principal settlement with its fort, on the southern tip of Manhattan Island, was named Nieuw Amsterdam. In 1614, the Dutch had built Fort Orange, up the "North River" (the Hudson) as far as sailing vessels could navigate, about 136 miles north of New Amsterdam. By the 1620s, Fort Orange was adjoined by the village of Beverwyck, the present location of Albany. In 1651, the village of Wyltwyck was established 91 miles north of New Amsterdam on the west side of the North River, near the mouth of Rondout Creek. It is now Kingston.

Settling this new land was of minor importance to the West India Company. They were there primarily for the benefits of trade. Netherlanders were at the time enjoying the highest level of prosperity of any country in Europe and there was little economic incentive for Dutch men and women to emigrate to the New World. Of course, some did, but many of the settlers who came to New Netherland were from poorer countries such as Denmark, Norway or the principalities of Germany—or Englishmen such as John Bowne, who settled in Flushing on northwestern Long Island, and the Scotsman Alexander Leonard Glen (known as Sander Leendertse), who founded Scotia, to the west of Schenectady.

Once in New Netherland, Dutch was the common language of this diverse group, and Dutch modular H-bent construction the basis of their buildings. The H-bent, while a common construction form in the Netherlands, was just one of a number of choices there. But it reigned supreme in New Netherland. If other construction techniques were used in the first half-century of settlement, no examples of them survive.

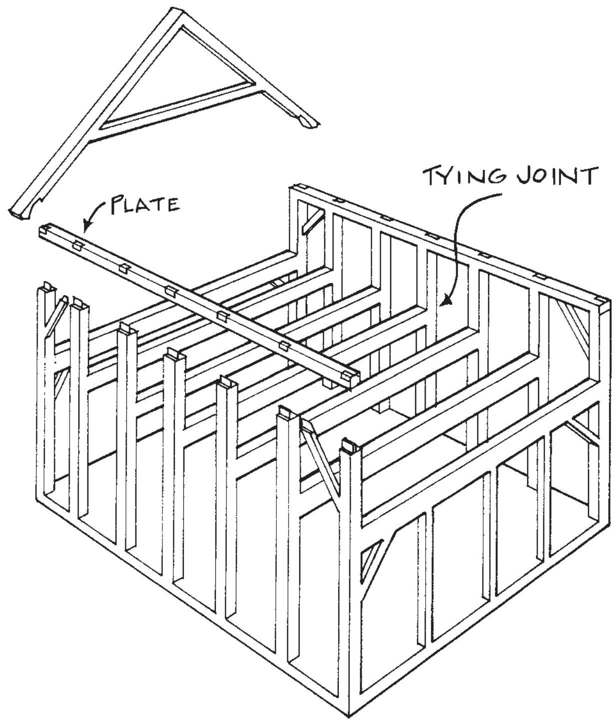
New Netherland was captured by the English in 1664 and renamed New York in honor of King Charles II's brother James, Duke of York (who in 1685 became King James II). At that time, the population of the province is estimated by the New Netherland Institute to have been about 10,000, and the population of New Amsterdam, likewise renamed New York, about 1500. The English allowed the Dutch to continue using their language and follow their religious practices without interference. And the Dutch structural and architectural idiom persisted.

The first shelters built by settlers in this land were primitive, said to have been cellars lined with boards and roofed over. More sophisticated structures began to be built, especially for the West India Company (for warehouses and for company officials) and such colonists as could afford them. Contracts survive for a number of these buildings, including some for combination house-barns, a common form in the rural Netherlands. An early drawing of New Amsterdam, looking across the East River from Brooklyn, was made about 1650 by Augustine Herrman, a Bohemian from Prague who settled in New Amsterdam and married a Dutch woman. The drawing shows a multitude of small, gable-fronted wooden houses clustered around the fort, as well as some timber-framed warehouses and several more imposing houses of brick or stone construction. The small wooden houses were similar to those one can still see today in the Zaan region of the Netherlands, north of Amsterdam, the area of the Netherlands where the timber trade flourished, especially shipbuilding. Wind-powered sawmills were used to convert imported logs into timber and boards. Before the middle of the 17th century, water-powered sawmills were also at work on the upper Hudson River, notably on the the west bank of the Normanskill south of Beverwyck.

A drawing of the same prospect made about 30 years later by Jasper Danckaerts shows the small wooden houses replaced by multi-story ones built of brick, but the depiction of the buildings is stylized and leaves much to the imagination. A few 18th-century and early 19th-century depictions exist of 17th-century Dutch houses in Manhattan dated with iron numerals. Working about 1850, the artist James Eights made a series of drawings showing street views of Albany as it would have looked in about 1800, lined with "old-fashioned," gable-fronted, story-and-a-half Dutch houses intermixed with newer ones of Georgian and Federal character. The Dutch aspect of the early houses is unmistakable: they would have been at home on the streets of Netherlands towns and villages. One Dutch house from the 1720s, the Johannes van Ostrande house, has managed to survive in Albany and is awaiting restoration at 48 Hudson Street. The first-story front of this house was of cross-bonded brick and the gable above was weatherboarded.

Most of the early houses of Albany were of timber-framed construction with gable fronts of brick. A few are shown with the hard yellow bricks brought to America as ballast. The gable edges were in a few instances stepped, but more often smooth and constructed with the triangular brickwork called by the Dutch *vlechtingen*; side walls were weatherboarded. The Stockade District in Schenectady retains a number of early gable-fronted houses of this construction. The best of these is the Abraham Yates house, built about 1725, which has survived with relatively minor modernizations (Fig. 1).

Only one building survives dated by dendrochronology to have been built in New Netherland before the English takeover in 1664, the John Bowne house at Flushing (now Queens County, part of



Jack Sobon

2 Representative drawing of standard New World Dutch house framing with closely spaced H-bents.

E. P. MacFarland, HABS

3 Pieter Claesen Wyckoff house, Brooklyn, N.Y., possibly ca. 1650, photographed in 1934. Bellcast-style overhang of roof at front is 18th-century revision.

New York City). It may date to 1661 as has long been claimed. The dendro results are not entirely clear because of imperfect core samples, but the first addition to the house is reliably dated as 1668. Nearly all of its original H-bent framing (such as in Fig. 2) survives, with stick-and-mud wall infill as well as the original floorboards.

The Pieter Claesen Wyckoff house (Fig. 3) in Brooklyn (now Kings County on southwestern Long Island, part of New York City) is claimed to be even older than the Bowne house. A date in the 1650s has been ascribed. Its framing timbers have not been dendro-dated, and in fact only part of the frame survives, the rear integral lean-to having been removed along with the original rafters in an early 19th-century rebuild. The frame of the Jan Martense Schenck house, formerly in southern Brooklyn, a much larger two-room structure with back-to-back jambless fireplaces, is preserved in the Brooklyn Museum. This frame is believed to date to about 1670. Its exterior cladding, doors and windows and interior features such as the fireplaces have been reconstructed.

The stone Pieter Bronck house at West Coxsackie in Greene County (south of Albany) has been given a date of 1663 but has not been dendro-dated. It represents a basic house type that could also have been timber framed: gable fronted (common in Old-World northern European buildings), one-and-a-half-story with knee walls, a single room with storage loft above and originally a jambless fireplace on the back wall (such as in Fig. 4). The house measures 25 ft. 10 in. across its front and 21 ft. 11 in. front to back. These dimensions are very consistent for a large number of single-cell Dutch house units that have been examined. Almost all of the surviving houses of single-cell type have had additional units added, at the back of the original section or on one or both sides. In the latter case, as in the Elmendorf house (ca. 1710) at Hurley, Ulster County, the original steep gable roof was removed after the additions were built and a new, over-all roof with lower pitch built at right angles to the former roof.

The majority of buildings in all areas of Dutch settlement (with certain exceptions) were of timber-framed construction. The Dutch three-aisled barn continued to be built wholly of timber into the early 19th century, but after about 1700 there was a changeover to the use of stone for houses, particularly in Rockland, Orange, Ulster and Greene counties. This changeover was so thorough that there are virtually no survivors of the earlier wooden-walled houses. Pieces of earlier timber-framed houses have been found reused in the stone-walled houses that replaced them.

Several years ago, a house that had been built with a stone gable front and timber-framed side walls was "discovered" in the village of Stone Ridge, Ulster County. The wooden walls survived because at an early date stone additions were built against both sides of the house and the roof re-oriented. To all purposes it looked like a long, all-stone house, a type frequent in the area resulting from additions to an original single-cell unit.

Timber construction, sometimes with brick end walls and hidden in side walls filled and veneered with brick, persisted in Columbia, Albany and Greene counties. Notable examples are the Luycas van Alen house at Kinderhook (1737) and the Leendert

Jack Sobon

4 Dutch jambless fireplace at Mabee Farm, Rotterdam, N.Y. Fireback is flush with wall of room, hearth is unenclosed at ends. Smoke rises through broad projecting hood to chimney above, supported on heavy joists. Fireback and hearth are representative only.

R. Merritt Lacey, HABS

5 Vreeland house in Leonia, Bergen County, New Jersey, 1786, with original bellcast overhang, photographed in 1936.

Bronck house (1738) at West Coxsackie. (The latter is connected to the Pieter Bronck house and both are open to the public.)

Surviving buildings from about the third decade of the 18th century continue to be discovered, compared with an almost total lack of survivals from the 17th century (certainly of authenticated buildings) and relatively few from the earliest years of the 18th. A good example, dated 1700 in glazed bricks on its façade, is the de Clark-de Wint house (Washington's Headquarters) at Tappan, Rockland County. A stone building with cross-bond brick façade and brick end gables, it has two rooms and a central hallway and retains rare early wood trim details relating to the Old World, such as an original interior doorway and complete mantel moldings for a jambless fireplace.

As the 18th century progressed, regional style variants of Dutch-American houses developed in the southern Hudson Valley, on western Long Island and in northern New Jersey, particularly in Bergen County. Roofs were made with a graceful curved (or "bellcast") overhang that extended beyond the walls about 3 ft. (Fig. 5). On western Long Island, these overhangs were common only at the fronts of houses. A few examples of this last variant are also to be found in southern Connecticut. The buildings of the upper Hudson, particularly around Albany, retained the closest connection with the Old World for the longest time. A prime example is the Teunis Slingerland house (1762) at Feura Bush, west of Albany. A gable-fronted town-house type built in the country, it has two rooms, cross-bond brick end walls and stone side walls, and retains its original doorways with their hardware and window frames with wood-muntined casements. It also has gable edges of the brick triangles or *vlechtingen*, modified in the 19th century (Fig. 6).

John R. Stevens

6 Teunis Slingerland house, 1762, Feura Bush, N.Y., with brick ends and stone sidewalls. Triangular brick *vlechtingen* follow the rake.

In the survivors from the middle years of the 18th century, the Dutch detailing of interior features is increasingly replaced with English Georgian details, particularly in higher-style houses. A significant change was the replacement of casement windows. The double-hung window came to be used almost exclusively after about 1750, although there are exceptions.

The gambrel roof became the iconic feature of the Dutch Colonial Revival houses of the early 20th century. In fact, like the bellcast overhangs mentioned earlier, the gambrel roof is not an import from the Netherlands. While the bellcast overhang had its origins in the early 18th century in the southern Hudson Valley, western Long Island and northern New Jersey, the gambrel roof was an import from Boston, purely English territory.

The earliest known gambrel roof in a Dutch context was on St. Peter's Episcopal Church in Albany, constructed by John Dunbar of Boston in 1715. He may also have been responsible for the gambrel-roofed Dutch Reformed Church built in Schenectady in 1734. The earliest house known to have had a gambrel roof is the Rensselaer-Nicholl house at Bethlehem, Albany County, ca. 1735, an upscale brick dwelling with such English-style interior joinery as paneled fireplace walls with bolection molding fireplace surrounds. (There are Dutch characteristics, however, in its divided exterior doors and their hardware, and the use of *vlechtingen* on its gable edges.)

After the middle of the 18th century, gambrel roofs came to be used fairly frequently, especially in upscale brick dwellings with New England–influenced joinery inside. The high point of the gambrel roof used in a Dutch context came at the end of the 18th century and extended into the third decade of the 19th, in the southern region of New York and New Jersey, where it was combined with the bellcast overhang. Significant examples are the Lefferts house in Prospect Park, Brooklyn, and the Vreeland house in Leonia, Bergen County, New Jersey (Fig. 6).

Roofs became less steep and many older houses had their roofs rebuilt with lower pitches, like the ca.-1723 Pieter Winne house at Bethlehem, Albany County. The jambless fireplace persisted well through the 18th century, and occasional examples have been found in relatively high-style houses of the use of both jambless and English jambed fireplaces installed at the same time. By the end of the 18th century, most of the jambless fireplaces had been rebuilt to the jambed type. A number of surviving high-style Federal-period houses in Bergen County, New Jersey, have old-fashioned beamed ceilings and jambless cooking fireplaces in their kitchen wings, and evidence that both main unit and wing were built at the same time. The Vreeland house at Leonia is a good example. The Dutch housekeeper's habit of using the jambless fireplace seems to have been a hard one to break!

By the end of the 18th century, ceiling beams had become smaller in section and were usually concealed under lath-and-plaster ceilings. Previously, ceiling beams had been a prominent feature of a house's interior. Of considerable size, they were smoothly planed, as also were the undersides of the floorboards.

Jack Sobon (above), Ken Rower (top)

7 At top, outside of exterior door at Mabee farm with knocker-latch. When rotated, bail handle lifts inner latch. Above, typical Dutch strap hinge with nailing pad, four of which are found on inner side of such doors.

The modular H-bent framing system (Fig. 2) continued to be used, although none of it was visible. Examples can be found almost to the middle of the 19th century. This construction found its way to Canada's provinces of Ontario, New Brunswick and Nova Scotia, largely through Loyalists who left their old homes during the American Revolution. The French Acadians who settled along the eastern shore of New Brunswick up to the border with Québec adopted this form, and a number of examples can be seen at the Village Historique Acadien at Caraquet, New Brunswick.

One persistent Dutch feature that survived down to houses built even into the Federal period was exterior door hardware, notably strap hinges with nailing pads and knocker-latches on entrance doors (Fig. 7).

In parallel with the survival of early American Dutch houses, many iconic Dutch three-aisled barns have also managed to come down to us (Figs. 8–9). Their interiors are a wonderful revelation of Dutch timber-framing technology. The characteristic Dutch barn was built with four bents and three bays, but barns with up to seven bays have been found. They are all gable-entrance buildings with a wide center aisle serving as a threshing floor and side aisles accommodating livestock. Examples have been seen where the center aisle is as little as 18 ft. wide; 25 ft. or so was a more common width, and some of the oldest barns had 30-ft.-wide threshing floors. The oldest surviving barn would seem to be at the Decker farm at Shawangunk, Ulster County, and dates to ca. 1750. An older barn with exceptionally fine timbering, the Marte Gerritsen van Bergen barn, once stood at Leeds, Greene County, but it was allowed to fall down in the 1970s.

New World Dutch barn form evolved over time from a steep roof with low side walls to a lower pitched roof with higher side walls. Most surviving barns date from after the Revolutionary War. In the older barns, the tie beams (anchor beams) of the essential H-bents terminate in extended through-tenons that are not only cross-pinned to the columns of the bents but also outside-wedged. The ends of the extended tenons were often cut in a semi-circular shape, or sometimes the corners of the tenons were clipped (Fig. 10). After 1800, extended tenons were generally given up.

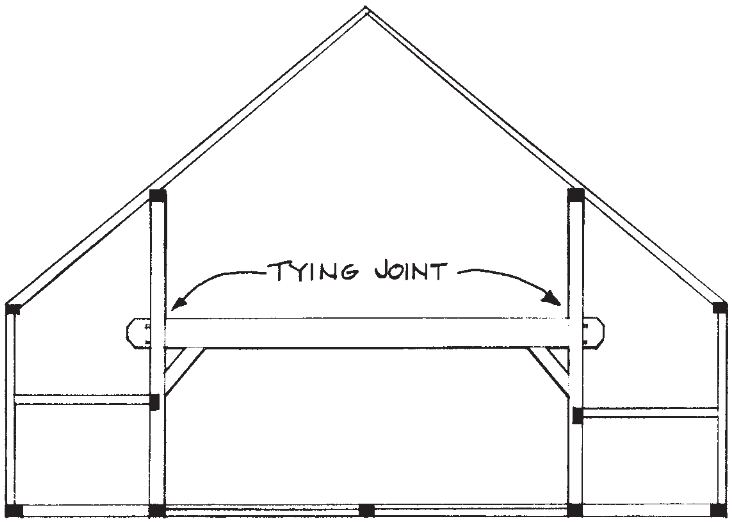
The Dutch barn form persisted almost to the middle of the 19th century. While a number are still in agricultural use, many Dutch barns have been lost because they were no longer functional for contemporary farmers. Fortunately, some have been preserved on their original sites and quite a few moved for preservation. Others have traveled long distances to be adapted for use as houses. An outstanding example is the Gremps-Fredericks barn, formerly at Stone Arabia, Montgomery County, which has been moved to serve as a house in northern Rensselaer County.

—John R. Stevens

John R. Stevens is the author of Dutch Vernacular Architecture in North America, 1640–1830, *published 2005 by Hudson Valley Vernacular Architecture (HVVA). Recent discoveries in New World Dutch vernacular architecture are covered in the HVVA newsletter.*

Ken Rower

8 Front of Wemple barn, Rotterdam, N.Y., mid-18th century. Small door, originally for animals, leads to side aisle as shown below.



Jack Sobon

9 Frame cross section of classic Dutch-American barn.

Nelson E. Baldwin, HABS

10 Anchor (tie) beam joint in Wemple barn. Three pins and two outside wedges secure the connection. Beam is about 12x22 in.

Plumb Line Scribe 2

IN the first part of this article (TF 96), we described the principles of the plumb line scribe method and stepped through the scribing of a simple intersection. We now proceed to the scribing of the demonstration hip roof frame (Fig. 2-1). It should be noted that throughout this article (including in Part 1), I reverse the accepted meanings of the terms *dragon beam* and *dragon tie*. It makes sense to me that the member directly receiving the hip and resisting its horizontal thrust should be labeled a tie. In all our instructions and drawings, then, the tie is the short member at the foot of the hip and in line with it.

Using the methods explained earlier, scribe all the intersections in the tie/plate layup (plan view in Fig. 2-2), establishing the upper and lower cheeks of the mortises and tenons as you go. Before removing the timbers, label each with a unique address. We typically stamp timbers with chisel marks, varying the size of the chisel according to which wall line the member is aligned or closest to. For this exercise we'll refer to them by their cardinal and ordinal orientation, North, South, NE, SE, etc. Remove the timbers one at a time from the layup and finish connecting lines. Draw and label as many joinery details as possible while in the layup, such as mortise and housing depths and tenon lengths, but many lines you will be unable to reach without disturbing a typical overlapping layup. Finish these off later when the timber is on the horses.

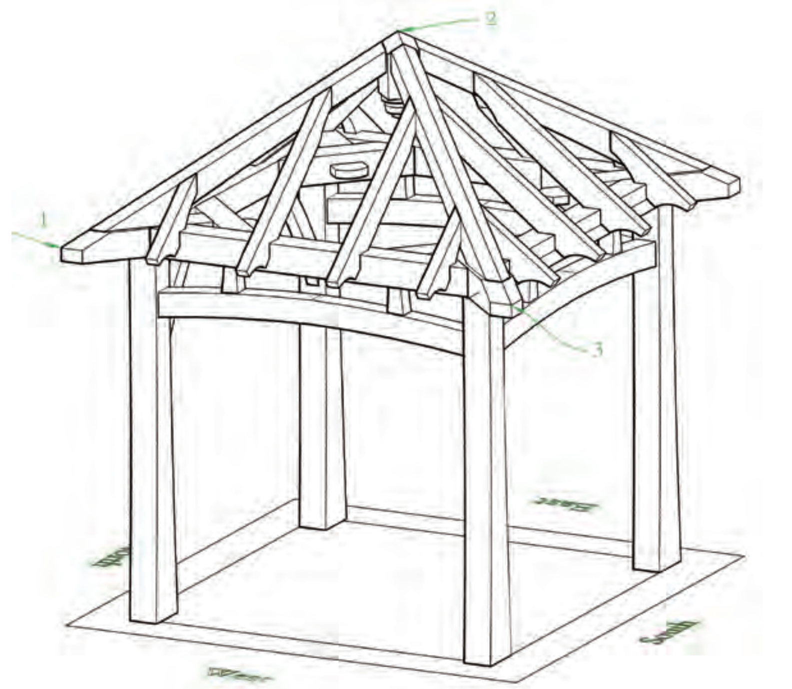
Our next layup, called the hip/tie, includes those timbers aligned along one of the diagonal planes through the center of the building (which we call a ridge plane), as shown in Fig. 2-3.

To start, let's look back at the first layup drawing (Fig. 2-2) to get some of the information we need to place the reference lines on the floor. The roof covers an area 10 ft. square. Measuring across the diagonals, we get 14 ft. 1 23/32 in. The run of a common rafter is half of the 10 ft., thus 5 ft. I would like the common pitch to be 9:12. At the center there will then be a gain of 9/12 of the 5 ft., or 3 ft. 9 in. above the eaves plane.

To obtain the reference lines on the floor shown in Fig. 2-4, snap a line 2 ft. or so longer than the diagonal measurement; this will be the baseline of the roof. On it, mark off points *A* and *B*, 14 ft. 1 23/32 in. apart, and a centerpoint *C* representing the center of the building, midway between them. Construct a perpendicular line through the centerpoint. (A method to construct this perpendicular line is shown in Fig. 2-4.) Strike arcs of the same radius from *A* and *B* so that they cross at *D* above the baseline. (To facilitate such drawing, I typically drill a small hole through a tape measure on the 1-ft. mark. With an awl inserted into this hole the tape measure becomes a variable length compass beam with the awl serving as its pivot.) Draw a line connecting *D* and *C*.

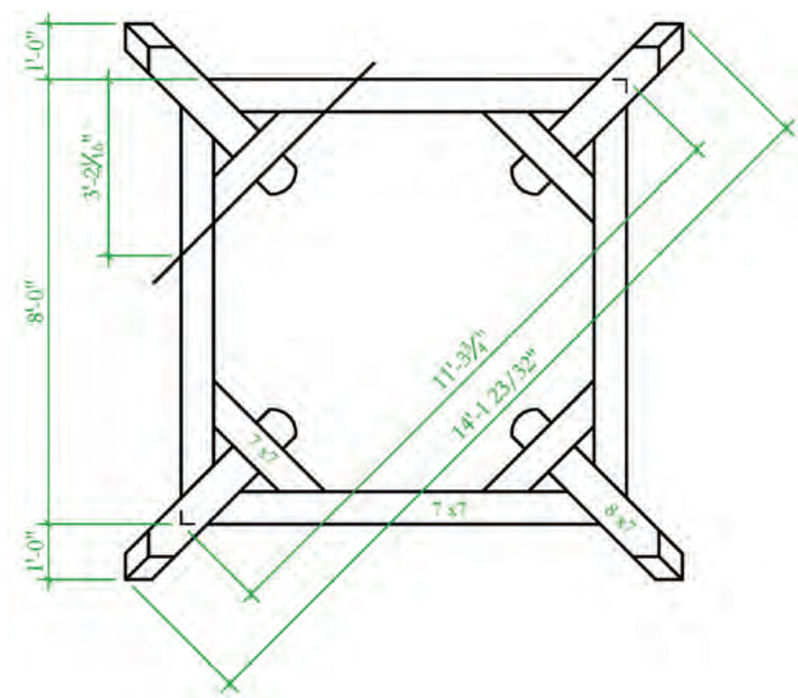
Measure 3 ft. 9 in. (dimension from Fig. 2-3) from *C* along line *CD* to locate the peak at *E*. Snap lines from this point to *A* and *B*. These lines represent the ridges of the hip and will be called the hip lines. In the section view (Fig. 2-3), notice that the top of tie is shown 3¾ in. above the point where the baseline of the roof intersects the hip line. Snap two short lines parallel to and 3¾ in. above the roof baseline, representing top of tie. Establish 1½-in. offsets over the top of the ties and hips and an offset to one side of the centerline large enough to clear the edge of the bosspin, say 6 in. Place 2-ft. marks along the centerline measured from its intersection with the hip lines and others along the hip lines measured from their intersection with the baseline. Finally, place the 2½-ft. marks needed to relocate the tie along the baseline measured from its intersection with the hip to complete the layout floor.

As in the previous layup of the ties and plates, the timbers need datum lines before being placed on the floor. When lining out the hips, remember that they, like the plates, will eventually be going into the roof layups in a rotated orientation. Therefore, hardpoints will be needed to establish the centered datums top and bottom and the standard 1½-in. datum on the sides. The bosspin eventually will be rotated as well, but because its sides are rectilinear (in its unembellished state) and will always be perpendicular to the planes that its datums represent, hardpoints are not necessary. Line out the bosspin in the normal manner with datums centered on each side.

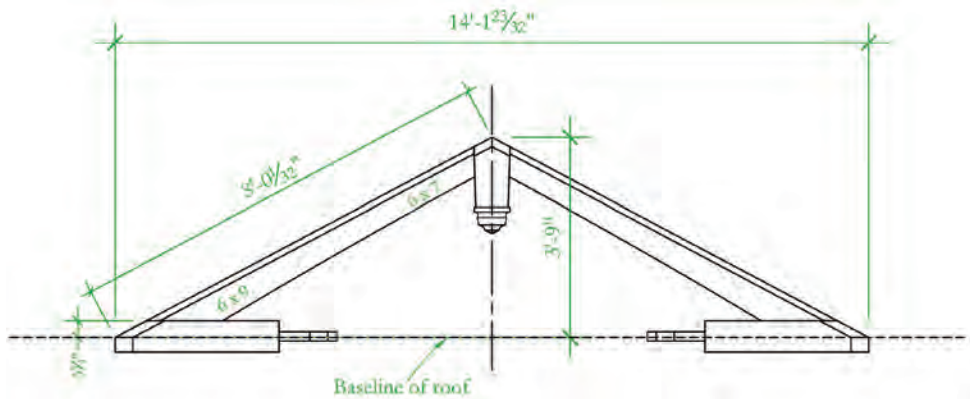


Drawings and photos Glenn Dodge

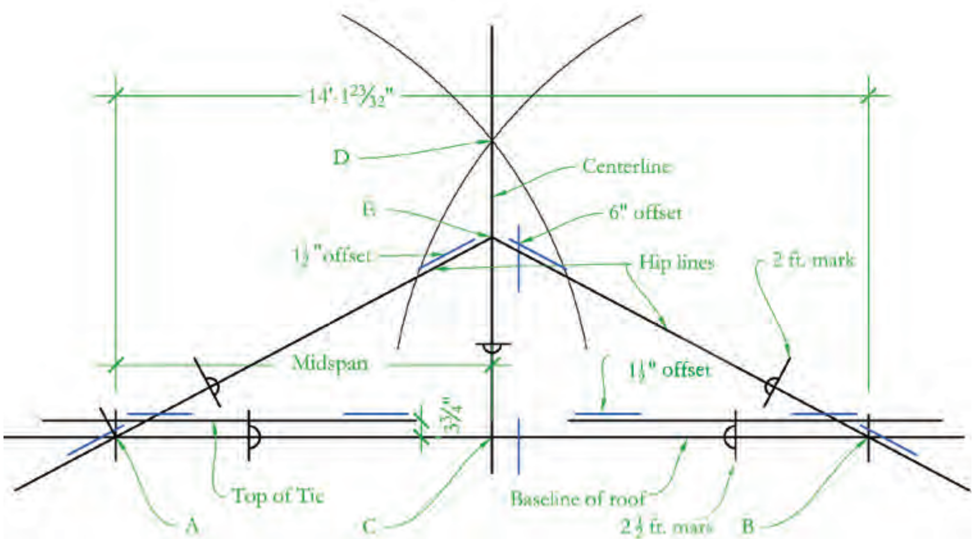
2-1 Perspective view of demonstration structure with hip roof.



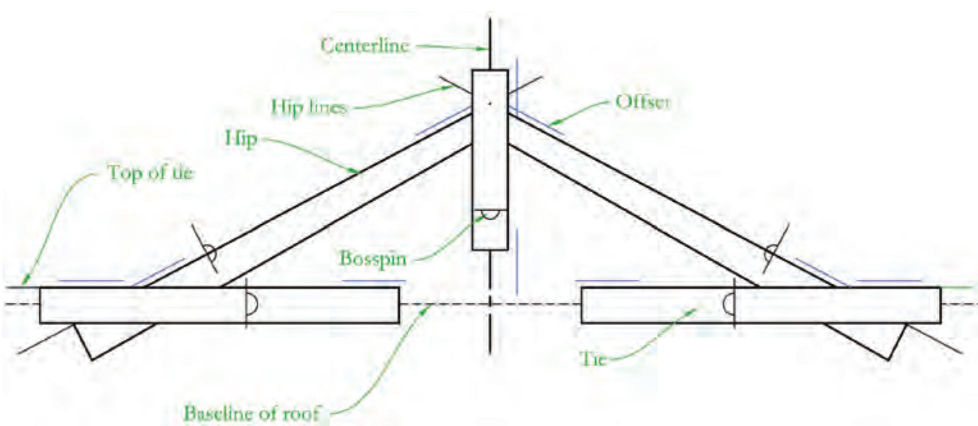
2-2 Plan view of tie/plate layup.



2-3 Section view of the hip/tie layup.



2-4 Floor lines of the hip/tie layup with offsets.

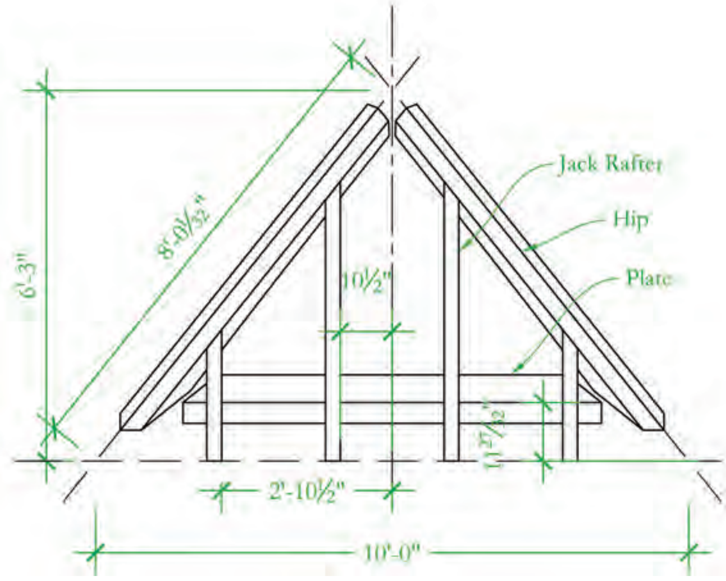


2-5 Hip/tie timbers laid in.

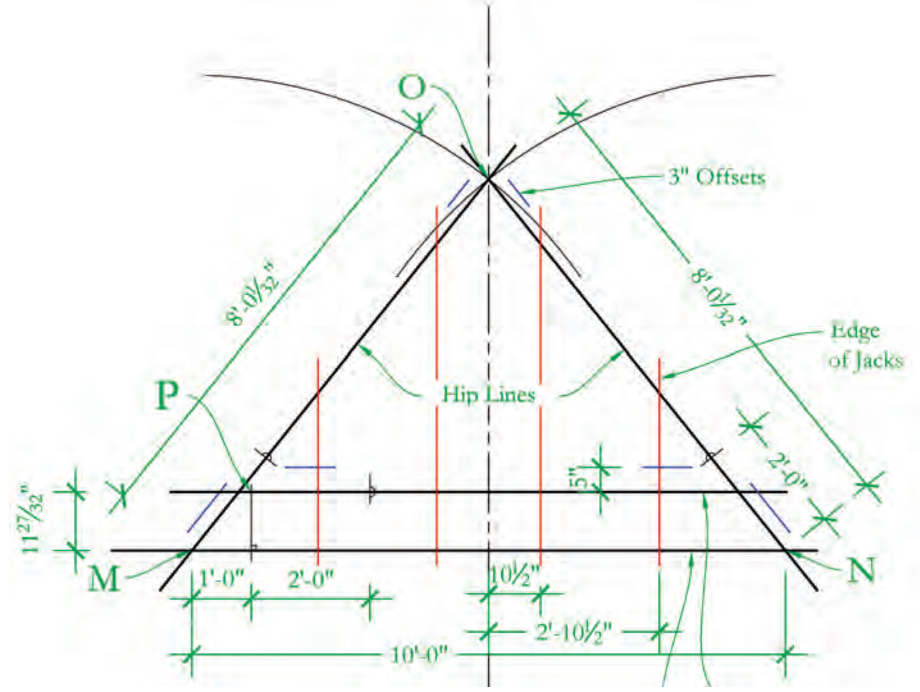
2-6 Bringing up a 2-ft. mark.

Also as with the plates, it will be useful to rough-cut the upper end of the hips before laying in, so they can be placed on the same level without interference. Using a bevel gauge or a framing square, determine the pitch between the hip line and the centerline as drawn on the floor, mark it on the upper end of the hip and cut it. Lay in the hips first, level and align them with their references. Lay in the bosspin on the second level. Roughly place the SE tie, then use a level to check the position of its 2½-ft. mark with its corresponding mark on the floor. Level and adjust its alignment in the normal fashion, then check the 2½-ft. mark again and adjust as necessary. Check all adjustments again, then lay in the NW tie. Fig. 2-5 shows the completed layup. Using a builder's level standing plumb, bring up the 2-ft. marks from the floor (Fig. 2-6) onto the hips and bosspin and then scribe. Be careful to address the hips appropriately to match the ties to which they were scribed. Label the bosspin so that its SE and NW sides are apparent.

After removing all of these timbers, start the next layup by laying in the other two hips. Be careful to rotate and reorient the bosspin to the new layup. Remember the 2-ft. mark when leveling and positioning. Taking your cue from the orientation of the bosspin, choose the appropriate side to lay in the SW and NE ties and proceed as in the previous layup.



2-7 Section view of roof layup.



2-8 Floor layout for roof layup.

The Roof Layups. For this last group of layups, our goal is to describe the compound angular joinery for the jack rafters where they join the hips at the upper end and the simple angular joinery where they join the plates at the lower end.

Like the preceding layups, the first roof layup needs to be considered in a plane in which all the members can be viewed and drawn at their true length. The plane is defined by three points, at the peak and at the ends of two adjacent hip lines where they meet the eaves line. In Fig. 2-1, the points are noted as *1, 2, 3,* and Fig. 2-7 shows the members for the layup in proper relationship to each other.

To lay out the lines on the floor (Fig. 2-8), start by snapping a line about 12 ft. long. Mark off two points *M* and *N* 10 ft. apart to represent the length of the eaves line. From Fig. 2-3, we have the length of the hip line *AE* (8 ft. ⅟32 in.), and from *M* and *N* we can strike intersecting arcs of this radius to locate point *O*. From *O*, snap a line to each of the first two points. These are the same as the hip lines from the previous layup. Set 2-ft. marks along these hip lines starting from the intersection with the eaves line. This is enough information to locate the hips, but locating the reference line of the plate is a little more complicated.

Fig. 2-9 shows a section through the center of the structure perpendicular to the roof plane. The plate evidently does not intersect the roof plane, but we can determine its location if we keep in mind the direction in which the timbers are being viewed in Figs. 2-7 and 2-8—that is, perpendicular to the roof plane. Fig. 2-9 illustrates that when the layup is viewed from this direction, indicated by the arrow, the corner of the plate where the hardpoints are located is 11²⁷⁄₃₂ in. from the eaves line, as measured along the roof plane.

On the layout floor, draw a parallel line 11²⁷⁄₃₂ in. away from the eaves line as in Fig. 2-8. To find the location of the 2-ft. mark for the plate, remember that the plate line is 1 ft. away from the eaves line in plan view, so measure in along the eaves line 1 ft. and make a mark. Square up from this mark to intersect the plate line at *P*, which represents the point at which the plate lines cross. Now measure 2 ft. along the plate line and make the symbol for the 2-ft. mark.

Continuing with Fig. 2-8 for the jack rafter floor layout, first mark the centerline, which runs through the peak and the midpoint of the eaves line. Construct parallel lines to either side at 10½ in. and 2 ft. 10½ in. respectively. These lines represent the edges of the jacks. Draw 5-in. offsets for the plate and 3-in. offsets for the hips (blue lines in Fig. 2-8), but none for the jacks. As the jacks do not align to any building plane on their sides, there is usually no need to place them using the accuracy afforded by an offset.

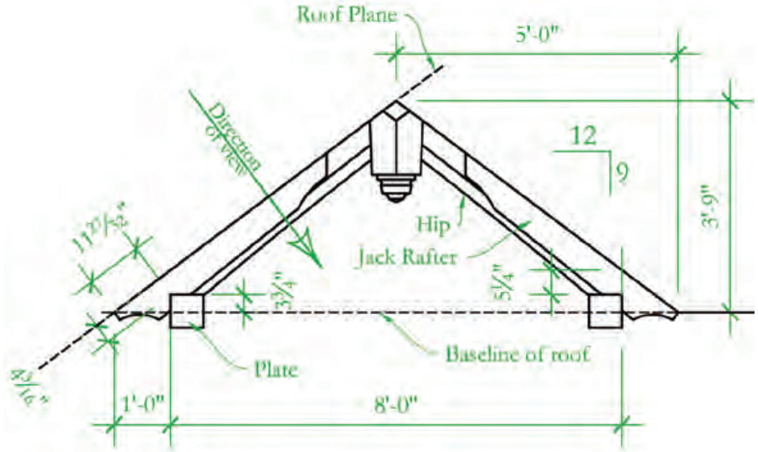
Before laying any timbers in, there is still some information that we need. In Fig. 2-7, the plate and the hips must be rotated about their x-axes so that their orientation and position relative to the roof plane and the other timbers is the same in the layup as it will be in the assembled frame. In Fig. 2-9 it can be seen that if the jacks are to lie level in the layup, the plate will have to be rotated by an amount equal to the roof pitch.

The Backing Angle. The rotation required for the hips is less obvious. Fig. 2-10 shows a view of the roof members looking directly up the hip ridge of the SW hip to the peak. From this view, the hip ridge and the peak have been reduced to a single point *S*. It can be seen that the hip (in red, with red centerline) is rotated in relation to the south roof plane an amount equal to the bevel angle on the top surface of the hip (in the plane of each panel of the compound roof), known as the *backing angle*. While we already know the pitch of the roof, we don't yet know the pitch of the backing. Published charts can give us backing angles for many regular hip roofs, and formulas to calculate the angles for irregular ones. For our purposes, we can use a simple geometric construction.

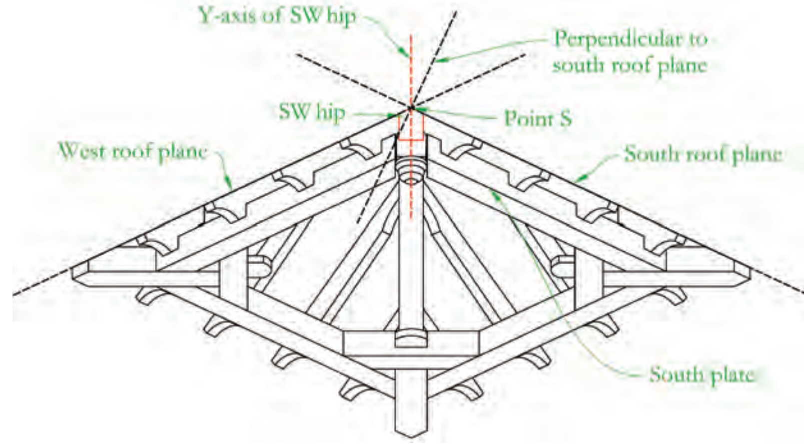
Fig. 2-11 shows a perspective view including sectioned hips, illustrating how the backing angle relates to the roof planes and the hip. To determine the pitch of the backing angle, we need values for the lines labeled "Backing angle run" and "Backing angle rise." While the perspective view is a useful visual, we can't measure off it. The following line construction is a way of using all the information from this three-dimensional example on a two-dimensional layout floor.

To start, it's convenient to return to the roof in plan as shown in Fig. 2-12. The true run of the hip is bounded by points *X* and *Y* on the SW tie line, and the common rise in Fig. 2-11, now *YZ,* has been laid perpendicular to it on the NW tie line. Connecting *X* to Z yields the SW hip line at its true length. Constructed in this manner, the lines bounded by these points are the same as those in Fig. 2-11, but the triangle they create has been laid over, so to speak, by pivoting it on the tie line, with the peak coming to rest at *Z* in Fig. 2-12.

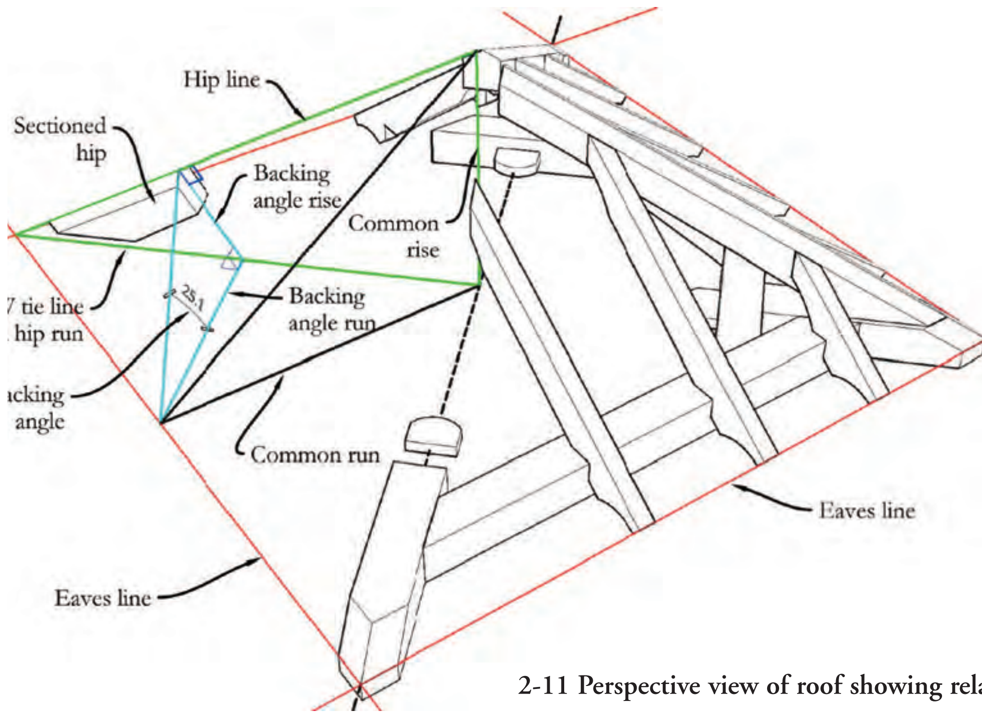
Continuing with the construction, randomly pick a point *A* along the SW tie line and erect a perpendicular from it to the south eaves line at *B*. *AB* is the length we will use for the backing angle run. From *A*, then construct a perpendicular to the hip line and mark point *C*. *AC* is the backing angle rise. At this point, we could



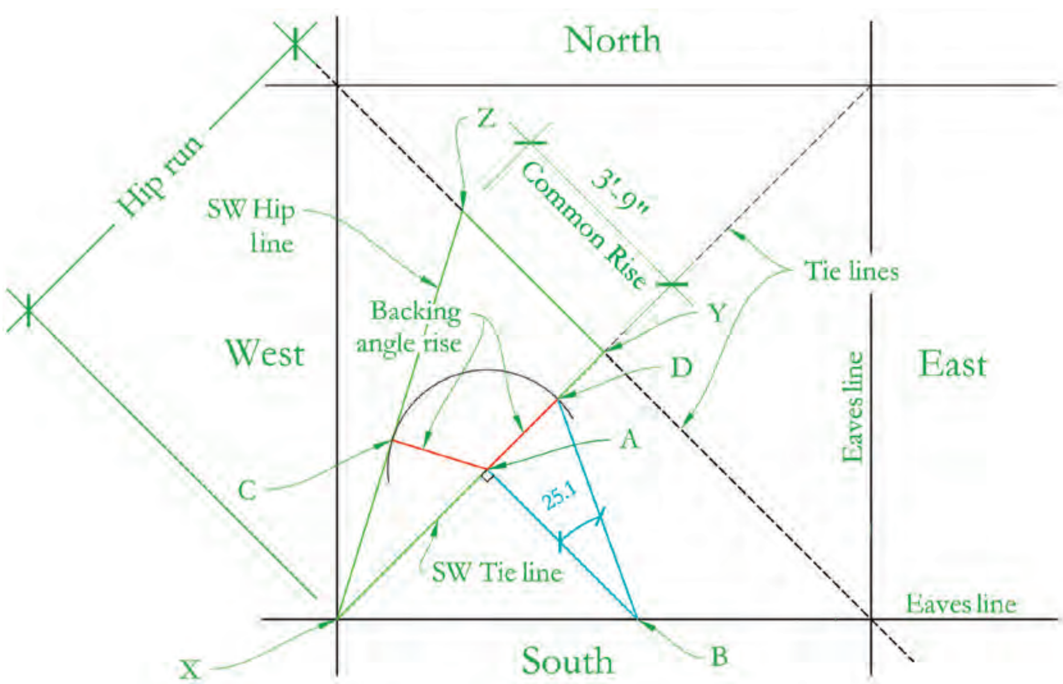
2-9 Section through center perpendicular to roof plane.



2-10 View up hip ridge with SW dragons removed.



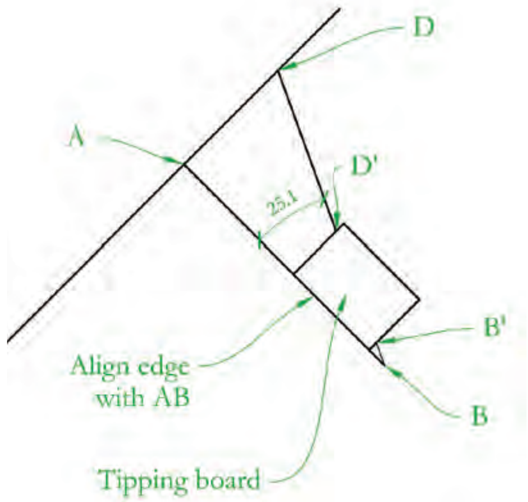
2-11 Perspective view of roof showing relation of backing angle.



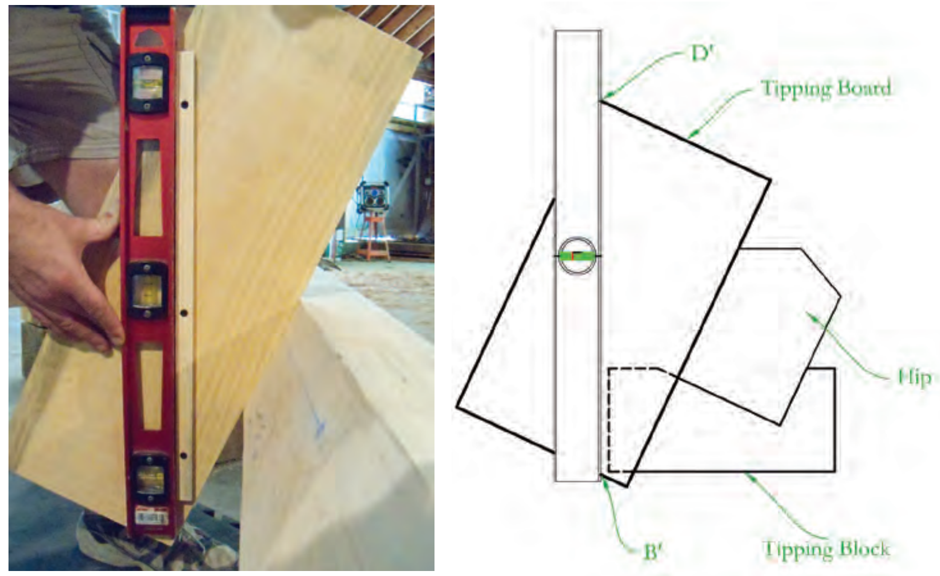
2-12 Geometric development of the backing angle.

measure these line segments, enter the values into a calculator or computer and obtain our backing angle. To continue geometrically, however, we use a compass to transfer the rise over to the SW tie line at *D* and then connect *D* to *B*. *ABD* is a directly transferable visual and physical representation of the backing angle.

To determine the pitch of the backing angle, place the outer edge of a framing square blade along *AB* with the 1-ft. mark of the blade on *B*. Note the dimension where line *BD* crosses the outside edge of the tongue. In this case it should be 5⅝ in., and therefore the pitch of the backing angle is 5⅝:12.



2-13 Marking the tipping board.



2-14 The tipping board in use.

We can use this information to build a fixture called a *tipping board* (Figs. 2-13 and 2-14), which adjusts the reading of a level by the amount of a given angle, in this case the backing angle. Take a piece of lumber about the thickness of your level and make it about 12 in. wide by 18 in. long, with nicely trued edges. Set one of the long edges along *AB* in Fig. 2-13, with the remainder of the board covering part of *BD*. (If all of *BD* is covered, then extend the line.) Make marks *B′* and *D′* where *BD* appears at the edges of the board, flip the board over and connect the marks. Now attach another thin piece of wood to the tipping board along this line, or attach the level directly to it. We will use this device later to adjust the orientation of the hips and plates in the roof layup.

To make another useful device, a *tipping block* (shown in use in Figs. 2-14, 2-16 and 2-17), take a thicker piece of wood, and again align a long edge to *AB* from Fig. 2-13. Position one end about 2 in. from *B*, mark the ends *B′* and *D′* and connect the marks on the flip side. This time, after connecting the marks, draw a line 3 in. parallel to the edge formerly aligned with *AB* and, where it crosses, use a square to draw a line perpendicularly away from the aforementioned edge. Cut away the waste along the lines indicated and use the block that's left to trace and cut three more similar blocks. Tipping blocks will be used in pairs to rotate the hips in the layup.

Note that if this roof were an irregular-pitch hip (different pitches for adjacent roof panels), then there would be two different backing angles on each hip. The procedure to find them would be the same, though, as shown in Fig. 2-15. Send a perpendicular line from point *A* to both the south and the west eaves lines. One of them will be shorter than the other. Draw a line from *A* perpendicular to the hip line. Notice that while the hip run is different for each side, the hip rise is the same. Finish the construction in the same manner as for a regular-pitch hip.

RETURNING to our layup, put the normal support blocks for the first hip in position and place one tipping block on each. Set the first hip in them tipped the appropriate way (Fig. 2-14). Though the rotation angle won't be perfect, it should be within a degree or two. Adjust the position of the hip. With the level aligned with the line on the tipping board, place the reference edge of the tipping board on the level mark of the hip and adjust the hip with shims until the level reads true. Adjust the position again including the 2-ft. mark and recheck the level. (Another way to level a rotated member is to use a digital smart level, but I have more confidence in the tipping board.)

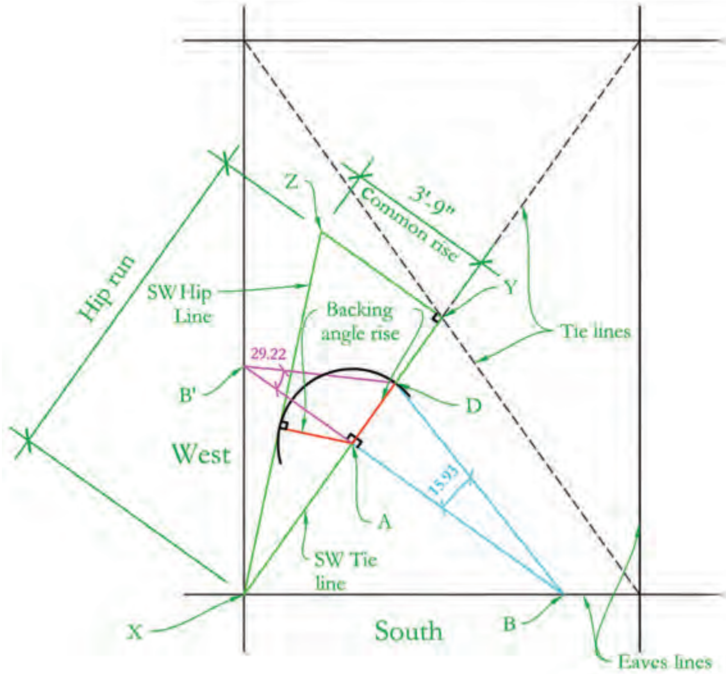
The datum lines snapped on the hip in the previous layup cannot be used in this layup because they have no relationship with the roof plane. Since the hip has been rotated, the planes they represent are not now parallel to the roof plane. (Only planes parallel or perpendicular to the layout floor have value within the layup.) The hardpoints established during the initial lining process define the location of the theoretical hip line and therefore are also in the roof plane. We are able to use them now to establish datum lines that represent a plane 1½ in. below the roof plane.

As shown in Fig. 2-16, place a 2-ft. level on the unbacked, rotated hip in the level position over one of the hardpoints. (If the hip had already been backed, then the level would actually rest on the hardpoint.) Measure down vertically from the lower edge of the level to the hardpoint. Because we are establishing a 1½-in. offset from the roof plane, we add 1½ in. to that measurement and find a point on the angled surface on the rafter side of the hip the combined distance below the lower edge of the level. Though this operation can be done by one person with a combination square, it is far less complicated if one person holds the level while another measures and marks.

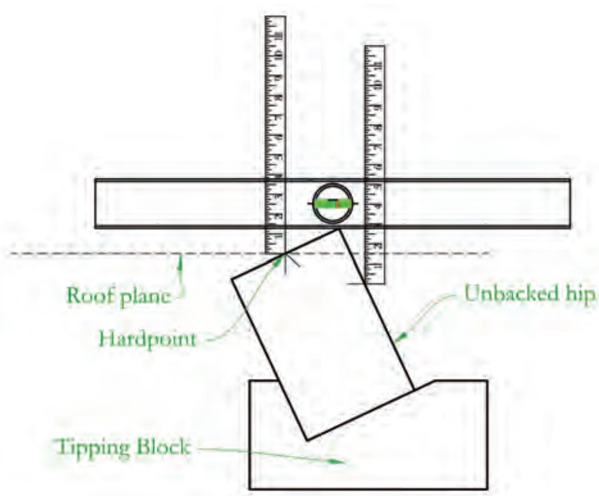
After doing the same at the other hardpoint on the other end, snap a line horizontally between them in the plane the line is meant to represent (Fig. 2-17). Using the same procedure, we could create marks on the other side of the hip and snap a corresponding datum to formally define the plane parallel to the floor, but it would serve no purpose. We only need one datum on each timber to establish a point-to-point distance when scribing with the trammel points, and we will only use this one to level the run of the hip. It is more important to label this datum "–1½ Roof," indicating the plane it refers to and the amount of the offset. Use this datum to level the run of the hip, recheck the roll and then recheck the position. The other hip will be laid in and lined in the same fashion.

Another tipping board can be made for the plate, or another line can be drawn on the first board. Place the plate in a set of tipping blocks made for a 9:12 pitch, and level and position the timber. Like the hip, it needs to have a datum snapped in the roof plane. But, referring back to Fig. 2-9, it can be seen that the corner of the plate where the hardpoint is located is theoretically already 4 3/16 in. away from the roof plane. If we snap a line 13/16 in. below the hard point it will represent a plane 5 in. below the roof plane. Construct this line similarly to the offset for the hip and label it "–5 Roof." (In general, anytime it's not obvious what a datum represents, it should be labeled.)

The jacks will have the 1½-in. datums on sides, top and

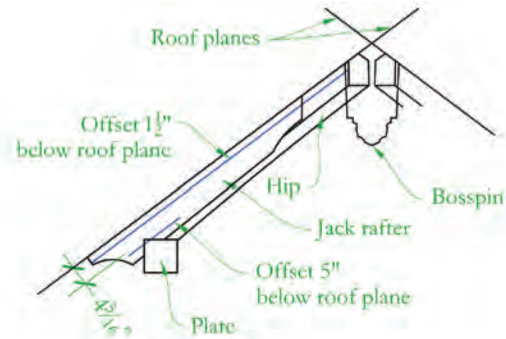


2-15 Development of backing angle for irregular pitch hip roof.



2-16 Locating roof offset using hardpoint.

2-17 Snapping the roof offset datum line.

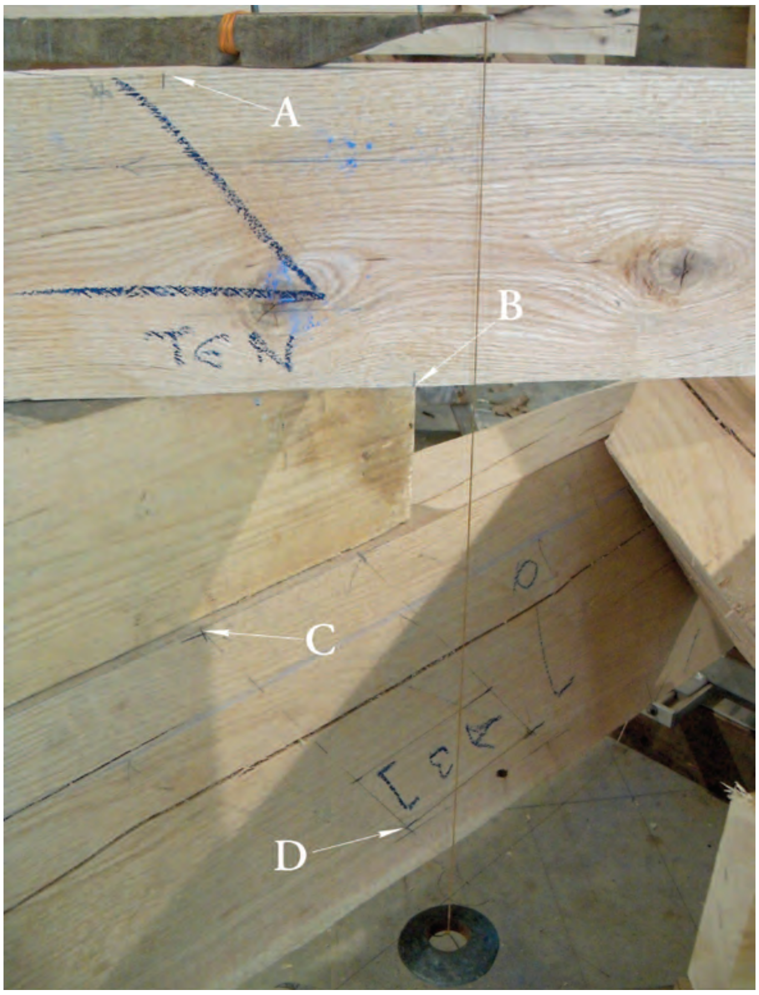


2-18 Roof plane offsets.

2-19 Jack/hip/plate layup.

bottom. In every layup, we always try to have a common datum on all the timbers. Normally it's 1½ in. below the horizontal reference plane (the roof plane in this layup). As seen in Fig. 2-18, the closest we can get to the roof plane with the plate is 5 in., but the jack rafters taper to 4 in. deep where they join the hip, so a datum 5 in. off the top of the jacks, and thus off the roof plane, would not work. At the end where the jacks cross over the plate, however, we can draw a short line parallel to the 1½-in. datum and offset an additional 3½ in. Label this short line "–5 Roof" as well. Now, even though there isn't a common datum throughout the whole layup, there is at least always a common datum at every joint. This is essential when setting off the vertical limits when you start to scribe.

Finish the layup (Fig. 2-19) by leveling and aligning the sides of the jacks with the reference lines on the floor.

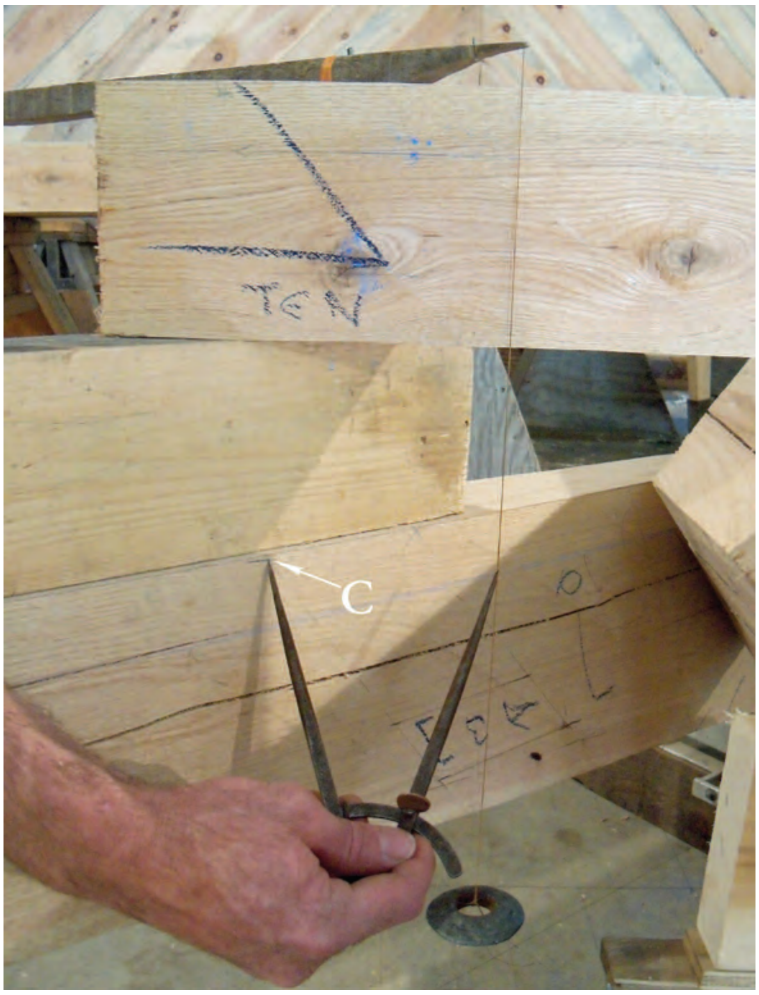


2-20 Compound joinery layout completed.

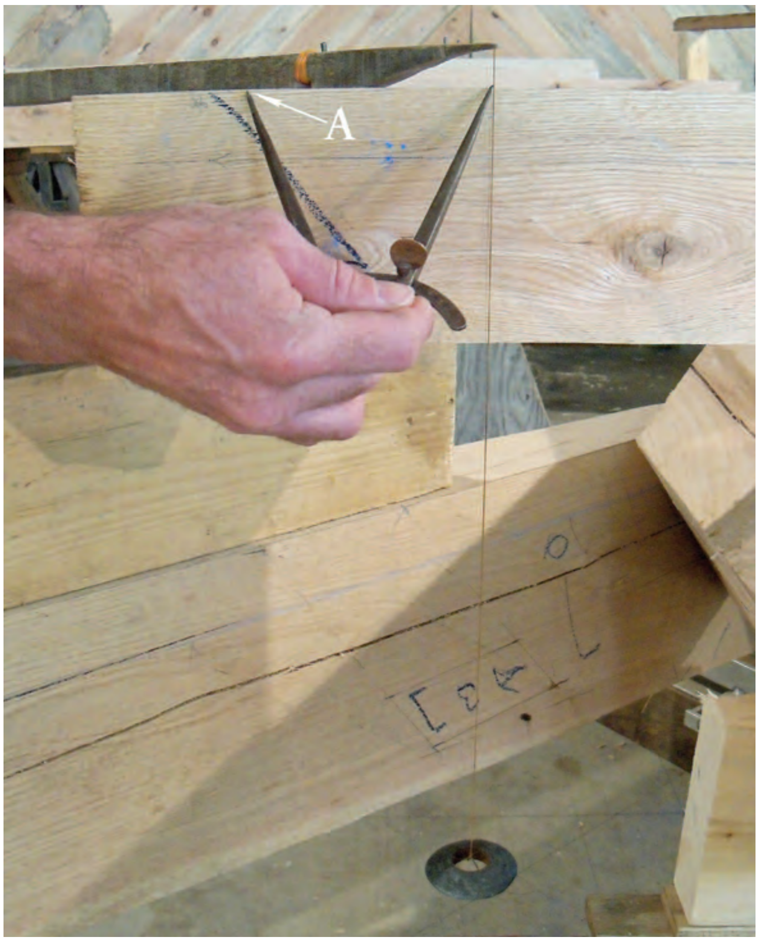
Compound Scribe. Scribing rotated timbers involves the same technique as before, but most steps are often performed twice. Following is a narrative of the steps to lay out the mortise and tenon for the hip-jack rafter connection. Figs. 2-20 through 2-24 show the roof layup with just the plate and a single hip and jack. The other hip and jacks have been removed to make the layup easier to view. Additionally, to aid in visualizing the necessary steps, the mortise and tenon have already been scribed in.

It's easiest to start by projecting the corners of the normally oriented timber (here the jack) onto that of the rotated one (the hip).

2-21 Gauging distance near *A* to find *C*.



2-22 Measuring from *C* to plumb line.



2-23 Transferring distance to locate *A*.

Viewing the layup as shown in Fig. 2-20, set the plumb line as close as you can to both timbers. Set the datum-to-datum dimension on the trammel points in the normal manner, as explained in Part 1 of this article (and shown there in Fig. 10), taking extra care to keep the points as close to plumb as possible. (Use the plumb line as a guide). Mark the upper vertical limit on the lower timber. In doing so, you will also find the approximate locations of *A* and *C*.

As shown in Fig. 2-21, place your thumbnail in the area of *A*, sight along the upper corner of the jack, gauge the distance between the plumb line and the jack showing on your thumbnail, and make a vertical mark on the hip at *C* an equal distance from the plumb line, as indicated by the index finger at the bottom of the photo. (The horizontal mark indicates the upper vertical limit on the hip.) This step accounts fairly precisely for the standoff of the plumb line from the timber surface at *A*.

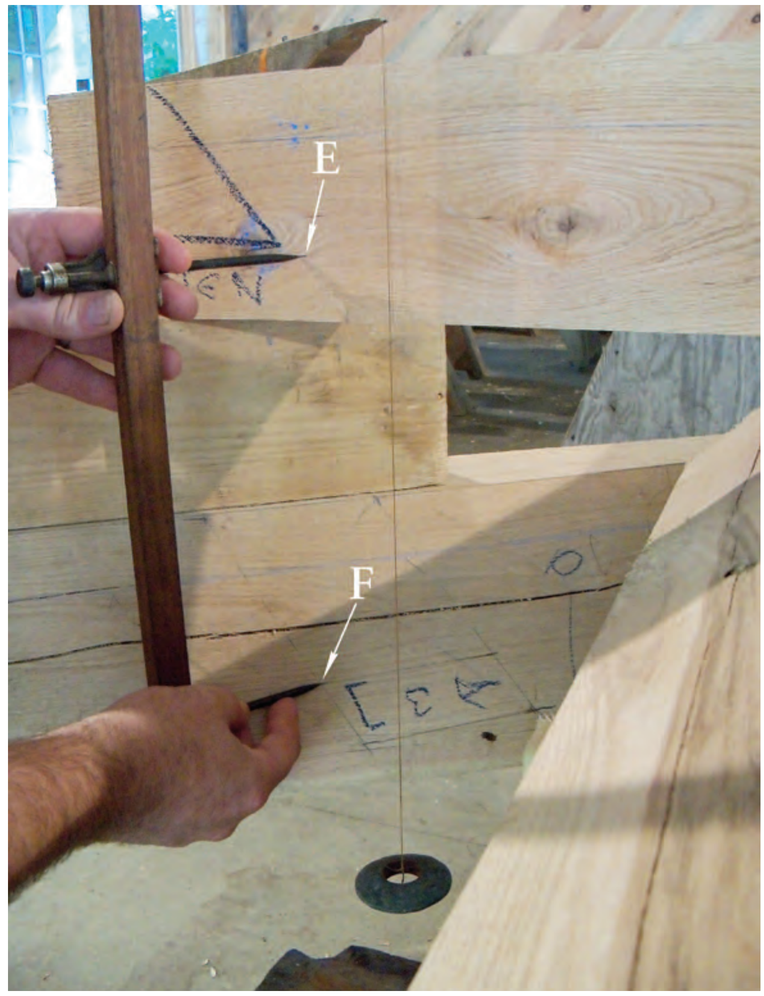
Using dividers, measure the horizontal distance from *C* to the plumb line as in Fig. 2-22. Transfer this dimension to the jack as in Fig. 2-23 to locate *A*. Recheck the points by placing your thumbnail on *A*, again sighting along the upper corner of the jack and gauging the distance to verify the mark initially made at *C*. Adjust *C* if necessary. If *C* needs to be repositioned, then likely so will *A*. Measure the distance from *C* to the plumb line again and use this measurement to adjust *A*. Finally check with the trammel points to ensure that *A* and *C* are the appropriate distance apart. Repeat the preceding steps to locate *B* and *D* in Fig. 2-20. Repeat for the other side of the jack and connect the points.

The jack will have a 1½ -in.-thick, barefaced (single-shouldered) tenon. Supposing the bottom surface of the jack is not tapered (usually the case), place the lower edge of a 1½-in.-wide steel rule (such as the tongue of a square) on *B* and flush with the bottom of the jack. Draw a line along the top edge of the rule and cross the line of intersection at *E*. This line is the upper arris of the tenon, where cheek and edge meet. Using the trammel points with the datum-to-datum measurement, place the upper trammel point at *E* and make a mark *F* where the lower trammel point crosses the line of intersection on the hip as shown in Fig. 2-24. Do the same from the other side of the jack and connect the points on the hip to define the upper cheek of the mortise. The completed mortise and tenon should appear as seen most clearly in Fig. 2-20.

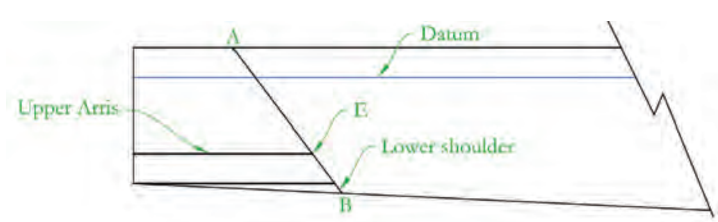
But what if the tenoned member were tapered, with the tenon thickness diminishing toward the end? If the steel rule is aligned with the lower edge, the tenon will not be parallel to the datum—unacceptable. The easiest remedy here is to raise the whole tenon up (while maintaining its parallel relationship with the datum) whatever distance is necessary to achieve its desired thickness. What was a barefaced tenon will now have a distinct lower cheek and a small lower shoulder (Fig. 2-25). Use the trammel points to raise the mortise layout the same distance.

The remaining compound scribes are done in the same manner, including the intersection with the plate. For each new layup, the hips will need a new snapped line to represent an offset from the roof plane being considered. Remember to hold dividers or trammels as close to vertical or horizontal as possible when measuring and marking. Keep your pencils and trammel and divider points thin and sharp. Always take a moment to deduce the general area where you think the scribe point will be before you take your first shot, and keep a good eraser nearby. Once you realize how accurate you can be, you'll want to hit it every time.

Since we concern ourselves generally with just four points of intersection, and then draw straight lines between them, we have a system that can deal with every sort of imperfection at the outer corners yet ignores all imperfections between the points. We account for this by flattening or even bellying the area between scribe points, generally with a slick or smaller paring chisel, sometimes a block plane. Because the distance between points is generally small, this is a quick process, usually less than a minute per joint. Often we would want to belly this part of the surface anyway, regardless of what layout system we had used, to account for the tendency of the mortised member (if boxed heart) to develop a convex surface as the timber dries out. Of course, we must be careful not to lose the scribe points when joining or flattening.



2-24 Locating upper cheek of mortise.



2-25 Adjusting joinery on tapered member.

Plumb line scribe should be thought of as a system rather than a technique. That's where its greatest advantages are found. Simply scribing a timber or two into a frame whose joinery was laid out by another method does not realize all the savings or benefits associated with scribing a whole frame in a planned manner. In this system, many steps are required (sometimes for reasons not immediately apparent) that seem excessively time-consuming—until the rewards are harvested later. To fully appreciate the efficiency and accuracy of the system, you have to try it and grow confident with it. Daily use has given me the faith and freedom to design frames that I would never have thought of otherwise. —Glenn Dodge

Glenn Dodge (gdodge@dodgco.com) owns Dodgco, New Boston, N.H., and has been designing and building with locally harvested timber since 1987. Will Truax, of Center Barnstead, N.H., collaborated on the development of plumb line scribe as well as its antecedent layout method, snap line square rule. This is the second part of a two-part article.

A Sojourn with the Compagnons

All photos Will Gusakov

1 Celebratory feast following adoption ceremony at Compagnon chapter house in Périgueux, Dordogne.

IN January I went to France through the nascent work-exchange program between the Timber Framers Guild and the Compagnons du Devoir, the French trades guild. Through the winter and spring, I worked as a restoration carpenter for Ateliers Férignac (ateliers-ferignac.com) at Hautefort in the Dordogne, a region of southwest France. Though I worked as a "normal" employee in a private company, I lived in the local Compagnon chapter house and was generally accepted and incorporated into their guild life. (Unfortunately, my stay there was cut short after less than four months because of an unforeseen paperwork problem. The issues are well known now and certainly won't be a problem for future sojourners.) A description follows of the education and training system of the Compagnons—not at all an exhaustive or authoritative account, but a recounting of what I saw and heard of guild life and training.

Les Compagnons du Devoir (The Companions of Duty) have a long, celebrated and complicated history in France. Founded sometime in the Middle Ages—the earliest written reference is from the 13th century—the Compagnons have persisted through the centuries as one or more professional guilds, made up of practitioners and trainees of many different crafts, surviving the industrial revolution and modern labor movements alike. Compagnons have been involved in the design, building and restoration of nearly all the famous structures in France (Notre-Dame cathedral, the Eiffel Tower) and some in other countries (the Statue of Liberty). The changing organization of these different guilds and different crafts over their history is bewildering, and today there are three different Compagnon guilds. Furthermore, each craft has its own suborganization under the umbrella of each guild, and there are geographical divisions as well. Despite this complication, the Compagnon guilds have in common a basic structure and mission. (See Jean Bernard's selected remarks, "The Companions of Duty," at www.farwesteditions.com/mft/Companions.htm, as well as *The Artisans and Guilds of France,* by Francois Icher, translated by John Goodman, 2000.)

My particular host was L'Association Ouvrière des Compagnons du Devoir du Tour de France (AOCDTF), the largest of the three and representative of *compagnonnage* in general. Within the association (www.compagnons-du-devoir.com) are 25 different crafts, mostly building trades such as stonemasonry, furniture making and roofing, but including others such as baking, leatherwork and tapestry weaving. *Charpentiers* (carpenters, as in structural framers of wood) within the AOCDTF are 825 strong, with another 406 currently in training; they represent about 15 percent of all carpenters in France.

Training Progression. The training of a Compagnon carpenter is a long undertaking, typically lasting six to ten years. Young men enter training as young as 14 and progress through a series of levels until officially received as Compagnon journeymen. Though women have been accepted into the Compagnon system since 2003, there are as yet relatively few women working in the heavier building trades. For that reason and for simplicity, this report assumes a male carpenter.

The first stage of training is a two-year apprenticeship with a single company, often close to home, and the *apprenti* continues to live at home for the duration. Apprentices usually earn about half of France's minimum wage while learning the rudiments of a craft.

Having completed his apprenticeship, the young man is called a *stagiaire*. He begins his *tour de France*, which may last for many years. During the tour, the guild places him in jobs with different companies in different cities; every six months he moves to a new location, staying in a chapter house with others on the tour. A few months before each move, the trainees fill out forms to list their top three preferred locations and preferred style of work (for a carpenter, this might be "restoration," or "green building"), though the guild doesn't guarantee that requests will be met and priority is given to senior trainees. Trainees find out their next destination about a month beforehand, so there isn't much time for planning.

When the *stagiaire* has progressed far enough in his training both on the job and in the drafting room, perhaps after a year on the tour, he will spend nights and weekends making a *pièce d'adoption*, a work that demonstrates he has mastered the skills taught up to this point. If accepted, he will be adopted in a special ceremony including his family. At this point, he is considered an *aspirant* and will be called not by his given name but by the name of the region he comes from. For example, someone from Bourgogne will be called "Bourgignon," someone from Normandy "Normand." A celebratory feast follows an adoption ceremony (Fig. 1).

The *aspirant* stage of the training is often the longest, lasting three or four years. This is the heart of the tour, traveling every six months, getting to know different parts of France, different ways of doing things at different companies, and steadily progressing in skill and earnings. When the *aspirant* is ready, he will begin working on his *pièce de réception*, a masterpiece to show that he is ready to be received as a Compagnon. Commonly an *aspirant* will spend five or six hundred hours of free time working on this piece. Among carpenters, the pieces are traditionally scale models (*maquettes*) perfectly joined by mortise and tenon and tiny pegs, though sometimes full-scale projects are built and donated to the public (Fig. 2).

If the *pièce de réception* is adequate, and the *aspirant* also passes the other rites and tests of his initiation (these are secret, known only by the initiated), he will be received as a Compagnon and given a name that reflects his attributes, for instance "Normand Loyal-Coeur," or "Loyal Heart of Normandy." At their reception, which lasts a full weekend, new Compagnons are given a wooden staff, a sash and other items to symbolize their status and craft.

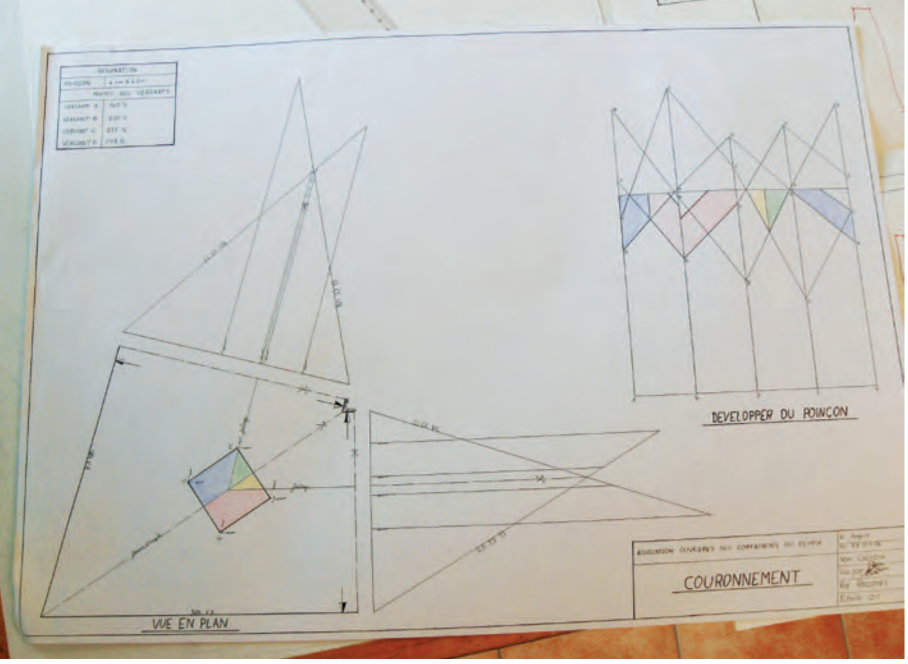
Throughout the training, each *aspirant* is encouraged to progress at his own pace, with an emphasis on fully absorbing lessons and skills before advancing; the time it takes an *aspirant* to move from apprentice to Compagnon may vary by several years. Once received, Compagnons are expected to remain as itinerants on the tour for two to three years after their reception, to continue their own education and to be responsible figures available to help younger trainees with their studies.

Life on the Tour. Though there are some modern aspects, the life of a Compagnon on the *tour de France* today seems much the same as it has been for hundreds of years. The physical and organizational backbone of the tour is the chain of *maisons des Compagnons*, regional chapter houses sprinkled all over France that shelter anywhere from 10 to 200 trainees. These are often beautiful old buildings that have been owned and maintained by Compagnons for centuries. The chapter house in the center of Paris dates from the 16th century, for example, and the converted stone sheep barn in Hautefort where I stayed was built in the 17th century (Fig. 3).

Life at the chapter houses resembles that at a college dormitory or fraternity. Rooms are shared by two or three people, bathrooms are communal and everyone eats together in a dining hall. Residents pay a monthly fee for room and board (very reasonable, about $650 when I was there). In all but the smallest chapter houses, there is a paid staff who prepare meals and do some cleaning. In Hautefort, which houses about 15, we shared cleaning chores, and meals during the week were delivered by a local caterer. We cooked for ourselves or ate out on the weekends.

2 A *pièce de réception* (a masterpiece) displayed at the 2010 Congress of AOCDTF carpenters, held in the mountain town of Oloron-Ste.-Marie, in the Pyrenees.

3 The Compagnon chapter house in Hautefort, Dordogne, a restored and adapted sheep barn built in the 17th century.



4 Finished drawing exercise. Note development of four faces of kingpost (*poinçon*) at right.

5 *Aspirant* carpenter "Nantais" (among motorbikes) laying out full-scale developed drawing on shop floor in Hautefort. He will build directly from drawing.

The bigger houses serve as regional centers, where smaller *maisons* that are part of the same *cayenne* (chapter) gather for adoptions and other ceremonies. These central houses are supervised by a *prévôt* (provost) and a *mère* (mother) or *dame-hôtesse* (hostess). The provost has many duties. He oversees the social and work life of the trainees, keeping an eye on their progress and behavior, making sure that they are studying enough and fulfilling their duties within the chapter house. In addition, the provost is responsible for the job placement of the incoming crop of itinerants every six months and for coordinating the recruitment efforts of the guild, giving presentations in local high schools in a bid to attract more apprentices.

The hostess or mother of the house is charged with overseeing the cooking and cleaning, and with looking out for the physical and emotional well-being of all of the members of the house. The title *mère* is an honorific, only awarded to a woman who has served the guild long and well, and who has passed her own initiation ceremony into the motherhood.

All the chapter houses, large and small, are equipped with workshops and drafting rooms with tools, paper and supplies. It is a general expectation of all living in the house to be working on their studies (whether drafting or building something) weeknights from 8 to 10 and Saturdays 8 to noon. Of course there were some exceptions, but I was impressed with the way that almost everyone buckled down to work each night after a full day of working out at a company. Generally, the received Compagnons are available in the drafting room during study hours to answer questions and lend a hand. This is a good example of the strong ethic of mutual aid and giving back that pervades the Compagnon community.

Workshop Education. The education of guild trainees extends beyond the workplace and the classrooms at the chapter house. For five weeks a year, each student goes to specific workshop classes called *stages* to learn about particular aspects of the trade. For a carpenter, a week might be spent learning framing systems for round roofs, or jobsite safety, or business practices. As I understand them, many of these classes are specifically required for advancement while others are electives. The workshops are held at larger chapter houses and taught by older Compagnons who have signed on to teach for one or more years, choosing to serve the guild and the trainees over the better money to be made working for a private company.

The trainees are not only allowed time off from their jobs to go to these *stages*, but they are paid their normal salaries for the weeks they are gone. I asked a few workers and my own employer if companies resent this extra expense, but the consensus was that the absences are accepted as a necessary cost of having well-trained employees. To make it a little easier on the companies, the classes are all held over the course of the winter to avoid summer's building crunch.

Le Trait. Developed drawing, coordinated drawn projections of planar sections through an object, generally called *le trait*, is a fundamental part of the training of a Compagnon carpenter. From the time of their initial apprenticeship until they are received as Compagnons, trainees study the art of developed drawing. Workbooks correspond with each year of training, full of information and exercises that test each new skill taught. These exercises are drawn out once or twice in pencil and verified by older students before being exactingly drawn in ink and presented to the senior carpenter in the house, who gives approval by signing off. All these drawing exercises are saved in a portfolio as proof of the trainee's developing skill.

The developed drawing skills aren't limited to the drafting room: aspiring carpenters commonly chalk out full-scale developed

6, 7 Singing from the Compagnon songbook after a feast. At right, recently received carpentry Compagnons in the regional group Cayenne de Périgueux show off *maquettes* they made for the 2010 St. Joseph's Day celebration.

drawings on the floor of the workshop to construct exercises (models, furniture, small timber assemblies) that test their recently gained skills in solving ever-more-complicated compound joinery problems (Figs. 4 and 5).

Camaraderie. During my time with the Compagnons, I was struck again and again by demonstrations of mutual support and care, among the *stagiaires* and *aspirants* living at the chapter houses and among the older *sédentaires* (settled journeymen, finished with the *tour*). Guild members between different crafts, and especially within a craft, share a tangible bond of brotherhood and duty. Part of this bond must come from the years of communal life on the tour, as well as countless shared feasts, ceremonies and events, all over the country and over the years. For years, a trainee lives only with other trainees and Compagnons, moving from town to town every six months, not knowing where he will travel next. Perhaps there isn't much room for relationships outside the guild (many lamented—and some celebrated—the difficulty of keeping a girlfriend through the years of nomadism), but within the guild a strong network develops that serves the members well throughout their careers. For example, the head of the carpentry arm of Ateliers Férignac, a Compagnon, was clearly an advocate for the guild within the company, ensuring that many positions were filled with itinerant trainees even though they changed every six months.

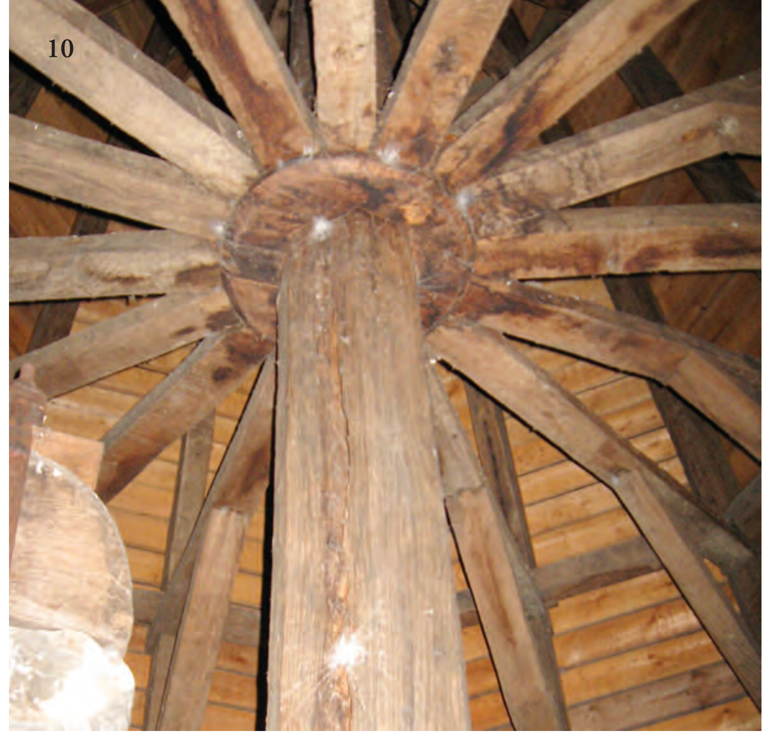
Compagnon life is not only about work. Our French friends know how to enjoy themselves. The yearly calendar is peppered with events and celebrations, including the feast days of patron saints—St. Joseph, in the case of carpenters. We in Hautefort thus hosted the 2010 St. Joseph's Day (March 19) celebration, attended by 200 of the surrounding guild carpenters and their guests. At this meal, as at adoptions and other traditional feasts, decorum calls for the *rouleur* (a kind of master of ceremonies) to select several companions to sing traditional songs from the Compagnon songbook. While the feasting pauses, the singer dons his colored sash and circles the hall, belting out an old song, while everyone joins in for the refrain. After the food is gone and the wine still flows, there will usually be lusty renditions of traditional (and often vulgar) folk songs. These events are also chances for trainees to show off recent pieces of work—scale models or pieces of furniture or sculpture—to their gathered peers (Figs. 6, 7).

The important annual carpenters' conference, which I witnessed in April, was attended by 500 carpenters, both young and old, from all over the country. They all come together every year to discuss the state of the trade and the guild and the outlook for the future; they also come to eat and drink together, and catch up with old friends. For most trainees, the conference is the one time each year to catch up with former housemates now scattered throughout France.

La Règle. Posted prominently in all of the chapter houses are large posters of *La Règle* (The Rule), an overarching moral statement about the ideals, duties and aspirations of *compagnonnage*. Also posted is a set of practical rules about the organization and function of the house, guidelines for communal living. ("At meals, all persons should be decent, all clothing clean. Established mealtimes are to be respected, unless work makes this impossible.") These rules are part of the guild's commitment to provide both a technical and a moral education, to develop competent workers who also have deep respect for their craft, their traditions and the community of humankind. Not only a technical training organization, the guild is steeped in the philosophy, even the spirituality, of work and workmanship. Jean Bernard (1908–1994), a distinguished French stonemason, a devoted editor and an important guild figure in the 20th century, put it thus:

> *Compagnonnage* is, for the worker, a school of life, a school in which the values and virtues of work are developed, a life in which the trade brings a substance which enriches the man, permits him to fulfill himself and all of his duties. . . . What then is the essential thing that *Compagnonnage* is dedicated to preserving? It is the conscience of the working man . . . leading toward the liberation of the individual, toward personal progress [and toward] responsibility for humanity, since our civilization like all other civilizations will be judged by the evidence of the works of its workers.

An American Carpenter in France. As an outsider coming into this fairly insular world, I was pleased and heartened by the welcome I was immediately shown—I was met at the airport in Paris and brought straight out to the bar and to dinner with a couple of carpenters. Most, if not all, of the Compagnon community was happy to meet and engage with me. Generally I was included as much as possible, whether going to a restaurant on the weekend with the guys from my chapter house, skiing in the Pyrenees with the *cayenne* (the larger regional group of several houses) or attending the annual carpenters' conference, usually closed to all but guild carpenters.



8 Ordiarp Church (Pyrénées-Atlantiques), 12th century. Exposed timber spire support and blank façade of church are unexplained.

9 Restored half-cone roof over round-end nave at back of church, with *enrayure* in tension at the base. (*Cf.* Bourganeuf, back cover.)

10 Oak spire mast and *enrayure* of compression struts high up in roof. Bracing, in compression, is tenoned as usual but not pegged.

Some Compagnons were more interested than others in hearing about American carpentry. I was asked many questions—what tools we use, how big our houses are, what woods we use—and particularly about stick framing, somewhat of a new fad in French carpentry. Most carpenters couldn't believe that we have built stick frames for well over 100 years here! In France, they are considered a new "green building" system because of their insulated walls (as opposed to the masonry walls of traditional French buildings). My interaction and integration with the community was limited by my rather elementary French, especially for the first few months. Even after becoming conversational, there were many questions that I couldn't ask or understand. (Language is the door to engagement and participation. I strongly encourage other American framers who want to work in France to do as much as possible to improve their French before starting work.)

La charpente in France has traditionally meant structural roof and floor framing, as walls are usually stone. Architectural millwork and finer woodworking—doors and windows, and furniture—fall under two other trades, respectively *menuiserie* and *ébénisterie*. True to tradition, the restoration work that I was assigned to mainly involved floors and roofs, ranging from butt-jointed and nailed joist systems to complex tenoned and pegged circular roof systems. Custom-fabricated metal tension elements were commonly and judiciously used.

I saw framing in European varieties of oak, pine, spruce and something that looked like hemlock; I also saw a fair amount of Douglas fir imported from North America. Most tooling in France is similar to ours, but there are differences—one-piece metal chisels are in use, for example, and small framing squares with legs maybe 6 in. and 10 in. long—and, of course, everything is sized metrically, so the framing chisel that I lugged over wasn't much good in their typical 30mm mortises. Makita, Mafell and Protool saws and mortisers are to be seen, though Japanese power tools cost twice as much in France as they do in the States, and inexplicably even German tools made in the EU are dearer.

11

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11 Detail of vault bracing to collar beams, church at Montlevicq (Indre), probably 12th century. Rafters continue down to wall plate.

12 View of nave roof framing restored earlier by Ateliers Férignac, with massive lengthwise bracing to dropped ridge, just visible.

13 Posts appear to carry interrupted collars and lengthwise girder, pass through vault and terminate in exposed tie beams below.

14 Three-quarter rear view of church exterior with half-transept and apses.

15 Possibly unique oak framing over elliptical vault of apse hidden on far side of exterior view.

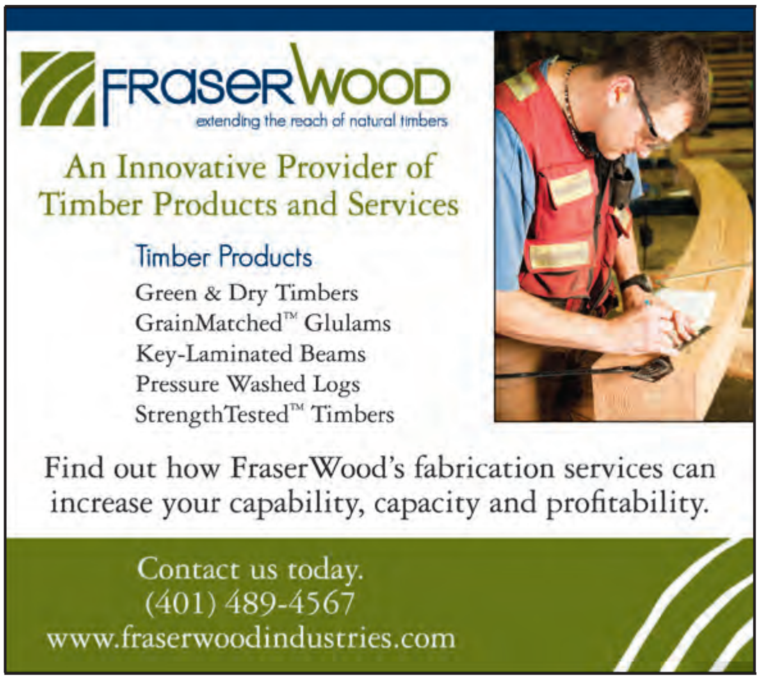
14

15

At work for Ateliers Férignac, I found that I could be useful at most tasks. Most of the work I did was general labor and light carpentry, not joinery. At Férignac, all timbers were cut in the shop by the two shop carpenters and then trucked to site and installed by the several traveling crews, of which I was a part. For the time that I worked there, I never once worked a day at the shop, but spent every week traveling to work sites from two to eight hours away. As a result, I saw a great variety of timber work (Figs. 8–15). Besides installing timber assemblies, I framed a floor system with dimensional lumber over carrying timbers, punched holes in masonry walls to receive beams, even once applied paste wax to a restored church balcony for a few days. While the simplicity of the work was a bit disappointing, it was also probably realistic. I needed several months of acclimation, to the language, the tooling, the metric system and the structural systems, before I felt ready to lay out and cut timbers. About the time I was forced to leave the country by the paperwork snafu, I felt confident enough to ask to spend some time cutting timbers in the shop, and the Compagnons offered to host me again. A contract for me to work in Paris starting in November is now on a tour of French officialdom.

—Will Gusakov

Will Gusakov (willgusakov@gmavt.net), a freelance living in Amherst, Massachusetts, has worked recently with Building Heritage in Huntington, Vermont. At least two other Timber Framers Guild members are lining up paperwork to work in France. Others interested in learning more about the exchange or pursuing timber work there should contact Will Gusakov. The Guild hopes before long to bring French Compagnon trainees over to work in North American companies. Any such companies interested in hosting a Compagnon trainee should contact Will Beemer at will@tfguild.org.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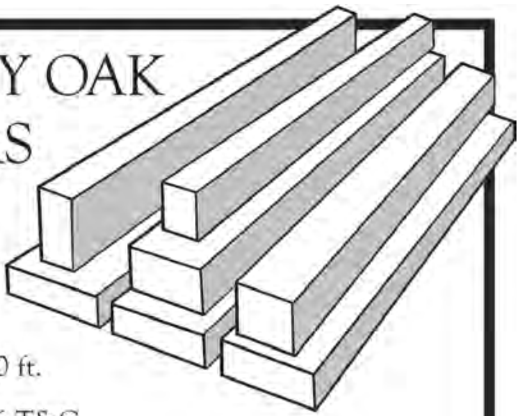

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Versatile Engineered Wood Solutions for Timber Framers

Field-proven quality, time-honored manufacturing practices from America's leading glulam producer

When the job calls for finely crafted engineered wood, Rosboro has the answers. Our glulam products are smart, green, and ready to serve the needs of today's timber framers.

Custom and Curved Glulam

Specially tailored sizes and curves to match the specific requirements of your project.

- Widths: up to $14\frac{1}{4}$"
- Depths: up to 53"
- Standard glulam depths or I-Joist compatible depths
- Lengths: up to 100'
- Inside radii as tight as 27'-6"

X-Beam

The industry's first 24F-V4, full framing-width glulam available in architectural appearance that's ideal for exposed applications.

Net Widths:

- Beams: $3\frac{1}{2}$", $5\frac{1}{2}$", $6\frac{3}{4}$", and $8\frac{3}{4}$"
- Columns: $3\frac{1}{2}$" x 6", $5\frac{1}{2}$" x $5\frac{1}{2}$", $5\frac{1}{2}$" x 6"

Depths:

- Glulam Depths: 6" through 30" in $1\frac{1}{2}$" increments
- I-Joist Depths: $9\frac{1}{2}$", $11\frac{7}{8}$", 14", 16" and 18"

Treated Glulam Beams and Columns

Pressure-treated Southern pine that's perfect for protecting decks, porches and balconies from rot and decay. Rosboro Treated Glulam has a balanced lay-up and is backed with a 25-year guarantee.

- Lengths: up to 48'
- Widths: $3\frac{1}{2}$" and $5\frac{1}{2}$"
- Depths: $9\frac{1}{2}$", $11\frac{7}{8}$", 14", 16" and 18"

Land and Environment

Throughout the years, Rosboro has maintained our commitment to sustainable forestry practices, and taken steps to further protect the environment by using waste wood and bark to generate energy for our manufacturing processes. Rosboro glulam is made from renewable 2nd and 3rd generation forests, and is manufactured with wet-use resins that meet or exceed the most stringent global emission standards.

Find out how Rosboro can provide resourceful solutions for your next Timber Frame project. Call 1-888-393-2304 or go to www.rosboro.com for more information.

Rosboro

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Rebuilt *enrayure* at 40-ft.-dia. base of oak conical roof framing in Bourganeuf (Creuse) in the Limousin region of France. Kingpost in tension hangs crossing lower chords. Fish-plates clamped to post via through-tenons and wedges provide added meat for pegging in one direction (square pegs just visible near bottom of lefthand plate); many small bolts secure spline, resisting tension in other half of crossing. Matched upper and lower horizontal struts running diagonally between chords clamp tenons of common spokes that radiate out to catch common rafter feet. Conical roofs may have several *enrayures*, in tension at rafter feet and in compression higher up on rafter length. Lower chords measure about 11 in. square.